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MONITORING OF CONVENTIONAL ENVIRONMENTAL PARAMETERS AT CERN

Annual Report 2003

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Abstract

The monitoring programme for conventional environmental parameters at CERN comprises the control of water released from CERN installations, checks of water quality in rivers receiving water from CERN and monitoring of ambient air quality at places close to the CERN sites. The control of released water includes continuous monitoring of pH and temperature at six CERN water outlets and periodical sampling and analysis campaigns to check in more details the quality of the water released from the CERN sites. Regular measurements of pH, temperature, concentration of dissolved oxygen and conductivity were performed in the water of the rivers Nant d'Avril (CH) and Le Lion (F) as well as in the water of the streams around the seven LHC sites PA2 – PA8. The concentrations of nitrogen oxides and ozone in the ambient air, which may be produced in accelerator facilities and released into the environment, were measured at two off-site monitoring stations in Maisonnex (CH) and Cessy (F). The report summarises the results of measurements carried out during the year 2003. No negative effect of CERN activities on the environment was observed.

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INTRODUCTION

This report summarises the result of measurements of conventional environmental parameters carried out at CERN during the year 2003. The report is divided into two main chapters. Chapter I deals with monitoring of water whilst Chapter II is devoted to monitoring of air.

Chapter I includes three sections. Section 1 describes the current monitoring programme for effluent water and water in rivers and streams receiving CERN surface water, cooling water and water from the Large Hadron Collider (LHC) and CNGS (CERN Neutrinos to Gran Sasso) civil engineering worksites. Section 2 gives the regulatory limits which are applicable to CERN effluents directly released into watercourses and to the quality of the water in the receiving rivers. Section 3 summarizes the results of the measurements. It refers to measurements performed effluents and in the rivers Nant d'Avril and Le Lion, in the streams around the LHC sites and in the streams affected by the LHC and CNGS civil engineering worksites. A table resuming all environmental events concerning water is also presented in Section 2.

The air-monitoring programme presented in Chapter II was initiated by CERN in 1986 to study ambient concentrations of selected noxious gases (nitrogen oxides and ozone), prior to and subsequent to the operation of the Large Electron-Positron Collider (LEP), which started in 1989. Results from earlier measurements can be found in Refs. [1] and [2]. Two emission stations located at the LEP ventilation outlets PA1 and PA5 were decommissioned at the end of the year 2000 when the LEP accelerator was definitively shut down. However, environmental measurements (immissions) are still performed at stations in Maisonnex and in Cessy, surveying the PS Complex (Proton Synchrotron) and the SPS (Super Proton Synchrotron) but also collecting data during the LHC pre-operational phase. Section 1 provides a general description of the monitoring programme, including information on the measured parameters and procedures for data collection and analysis. The results of the measurements are presented in Section 2 and assessed according to the standards adopted By CERN [3]. Finally, in Section 3 average monthly values of concentrations of nitrogen oxides and ozone measured by CERN are compared with corresponding values observed at two stations by the *Réseau d'Observation de la Pollution Atmosphérique de Genève* (ROPAG).

I WATER QUALITY MEASUREMENTS

1. Monitoring programme

1.1. Effluents

Sewage and industrial wastewater are directly discharged to the sewage stations STEP[1] Nant d'Avril (CH) and St. Genis-Pouilly (F). CERN surface water, cooling water and non-polluted industrial water are mainly released into two rivers:

- The Nant d'Avril in Switzerland, which receives most of its water from the CERN water discharges, comprising the cooling water of accelerators and infiltration water collected at LHC PA1, as well as the surface water and non-polluted industrial water from about 2/3 of the Meyrin site;
- The river Le Lion in France receiving the surface water and non-polluted industrial water from the Prévessin site and from the western part of the Meyrin site.

Water from the LHC sites (PA2 – PA8) and from the LHC and CNGS civil engineering worksites is discharged to rivers and streams around the sites. Water releases include water drained from the sites (rainwater), water collected in the LHC tunnel and pumped on the surface, and water originating in the civil engineering worksites.

The Swiss and French laws define limit values for numerous parameters, which do not need to be surveyed simultaneously and continuously in effluent water. Following a joint risk assessment, CERN agreed with the local Authorities in the Host States to continuously monitor the temperature and the pH at the water release points. This choice reflects the main potential risks involved in the CERN activities: (1) discharge of warm cooling water increasing the water temperature in rivers, and (2) accidental leak of acids or bases stored on the CERN sites, which could change the pH value of the river water.

Six continuous water-monitoring stations, which include flow measurement systems, are on the CERN sites: four at the outlets to the river Nant d'Avril, and two at the outlets to the river Le Lion. Stations are presented in Table I.1 and their location is shown in Figure I.1. The stations are equipped with a standard instrumentation for pH and temperature measurements. Flow measurements are carried out through ultrasonic level measurement. Temperature, pH and flow of effluent water are continuously measured and data can be retrieved on-line from a database to follow their evolution in time. If the pH value of the discharged water is out of the regulatory limits, a pH alarm is transmitted to the CERN Technical Control Room (TCR). The alarm triggers an automatic sampling of the effluent water and the CERN units responsible for interventions are called out. The main purpose of the alarms is to quickly detect possible pollution. The pollution source can be identified following a water pollution emergency plan and analyzing the sampled water.

At LHC PA7 and, in particular, at LHC PA8, release water might contain traces of natural liquid hydrocarbons. At PA7, filters and a hydrocarbon detection system are provided. At PA8, release water passes through an oil-water separator and a filter, which are emptied and exchanged regularly. The levels of hydrocarbons in the water discharged from PA8 are also continuously measured by CERN. Different alarms levels are set-up for both measuring points according to the level of oil contamination of the effluent water. In addition, the Geneva authorities (*Département de l'Intérieur, de l'Agriculture et de l'Environnement,* DIAE, Geneva) take regularly water samples just after the oil-water separator located at LHC PA8 and from the stream Le Nant that receives the drainage water to check the concentration of total hydrocarbons.

Besides continuous monitoring of water discharged from CERN, regular sampling campaigns are carried out to check the compliance of the water released from the CERN sites with the parameters listed in Table I.2. Water samples are taken at the limits of the CERN site drainage before the water outlets from the Meyrin, Prévessin and LHC PA1 / SPS BA6 sites. According to the surveyed parameter and the sampling conditions, instantaneous water samples or 24-hour water samples are taken. For most parameters, the samples are analyzed in the CERN environmental laboratory using a spectrophotometer.

[1] Station d'épuration.

Table I.1: Continuous water monitoring stations for pH and temperature at the CERN water outlets.

River of concern	Station and surveyed area	Possible pollution sources
Nant d'Avril	North-East part of the Meyrin site (NE)	Heating plant Cooling towers
	South-East part of the Meyrin site (SE)	Chemical store Dangerous waste storage area Cooling towers Demineralized water plant Electroplating
	BA6, cooling-water loop from the SPS[2] (BA6)	Cooling towers
	PA1, cooling-water loop from the LHC (PA1)	Cooling towers
Le Lion	Western part of the Meyrin site (W)	Demineralised water plant Cooling towers
	Prévessin site	Heating plant
		Chemical degreasing
		Cooling towers

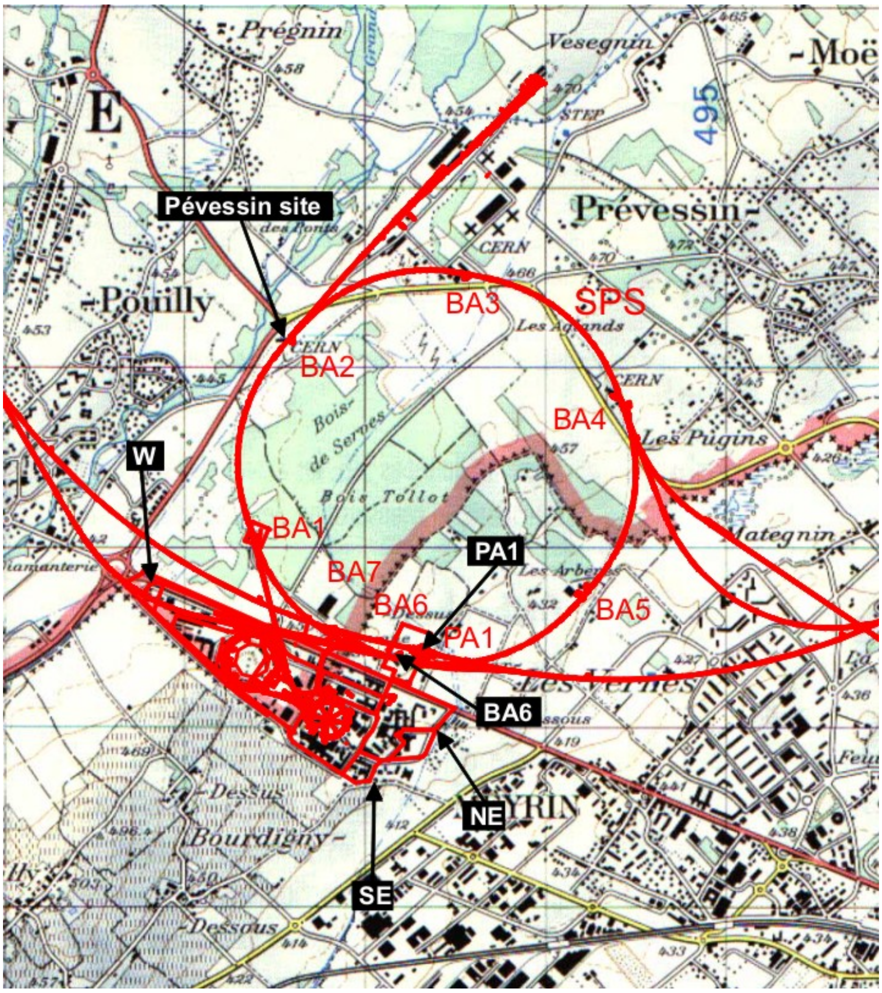


Figure I.1: Location of the automatic water monitoring stations.

[2] Although the SPS cooling circuit is closed, some water is released from the circuit during operations needed for maintaining the required water quality (e.g. de-concentration).

Table I.2: Parameters regularly measured in CERN effluents.

Parameter	Possible pollution source at CERN
Temperature	Discharge of cooling water
pH	Accidental leakage of acids or bases
Conductivity	Industrial activities and installations, leakage of demineralised water
Dissolved oxygen	Leakage of sanitary sewage, water treatment
Turbidity	Leakage of sanitary sewage, civil engineering
Suspended matter	Leakage of sanitary sewage, civil engineering
COD (Chemical oxygen demand)	Leakage of sanitary sewage water or non-biodegradable (in)-organic substances
DOC (Dissolved organic carbon)	leakage of sanitary sewage water, water treatment in cooling circuits
Ammonium	Leakage of sanitary sewage water
Nitrites	Leakage of sanitary sewage water, water treatment
Nitrates	Water treatment
Chlorides	Water treatment
Copper	Electroplating, corrosion of cooling circuits
Zinc	Water treatment, surface treatment
Iron	Welding, corrosion of cooling circuits
Aluminium	Corrosion of cooling circuits
Lead	Welding
Cadmium	Use of batteries
Nickel	Electroplating
Cyanides	Electroplating
Total hydrocarbons	Miscellaneous industrial activities and installations
PCBs (Polychlorinated biphenyls)	Former usage of transformers containing PCBs

1.2. Environmental measurements

To check the effect of CERN releases on the aquatic environment, regular visits are made to the rivers and streams receiving water from the CERN sites. During these visits, measurements of pH, temperature, concentration of dissolved oxygen and conductivity are carried out. In compliance with the Swiss and French legislations that demand to compare the pH, temperature and concentration of dissolved oxygen upstream and downstream of an outlet, the measurements are performed upstream and downstream if possible. Following the Swiss recommendations for river water analysis [4], the general appearance of the rivers and of the effluents in outlets is examined visually (hydrocarbons, colour, turbidity, vegetation, foam, etc…). Particular attention is given to watercourses influenced by the LHC and CNGS civil engineering worksites. The water originating in civil engineering may be turbid and alkaline and could affect the bedrock and the water quality of the streams receiving the effluents. Discharges from sources other than CERN are also observed, to avoid the Organization being unjustifiably blamed.

The pH, temperature, conductivity and concentration of dissolved oxygen are measured using a field instrument (automatic compensation of the temperature for the conductivity and oxygen probes). The measuring probes are calibrated each time before the visits.

1.2.1. Nant d’Avril and Le Lion

The location of the measuring points in the rivers Nant d’Avril and Le Lion is shown in Figure I.2. The nomenclature of the measuring points is explained in Table I.3. The river Nant d’Avril is covered from its source till the locality of Bourdigny. As CERN water is released in the covered part, which is difficult to access, the measurement upstream of the CERN water outlets in the Nant d’Avril is not carried out routinely.

Table I.3: Index of measuring points in the rivers Nant d'Avril and Le Lion, weekly measurements.

Code	River	Measuring place		CERN effluents
WNA1	Nant d'Avril	Downstream of CERN release points, municipality Bourdigny		Northeastern, Southeastern part of the Meyrin site, BA6 and PA1
WLL3 WLL4	Le Lion	Upstream Downstream	of the outlet from the Prévessin site, Le Bugnon, municipality St Genis	Prévessin site
WLL5 WLL6	Le Lion	Upstream Downstream	of the outlet from the western part of the Meyrin site, St Genis, bridge "Champion"	Western part of the Meyrin site

1.2.2. Rivers and streams receiving water from the LHC sites and civil engineering worksites

Water from the LHC sites and the civil engineering worksites, including CNGS worksite is discharged to the rivers and streams listed in Table I.4 and Table I.5, respectively. Measurements are carried out at least once per month for the LHC sites and once per week at the civil engineering worksites provided the water flow is sufficient. Water from LHC PA1 is drained into the Nant d'Avril (see the previous section). The geographic positions of the measuring points for the LHC sites PA2 – PA8 (upstream and downstream of CERN outlets) and civil engineering worksites are shown in Figure I.2 as well.

Table I.4: Index of measuring points in the rivers and streams receiving water from the LHC sites PA2 – PA8 (France), monthly measurements.

Code	River/stream	Measuring place		CERN effluents
WLA1	L'Allondon	Downstream of the release point from PA2, municipalities St Genis/Sergy		PA2
WLG1 WLG2	Le Gailloux	Upstream Downstream	of the outlet of meteoric water and water from the LHC underground areas, municipality St Genis, section Sergy-Crozet	PA3
WLV1 WLV2	La Varfeuille	Upstream Downstream	of the outlet from PA4 site, municipality Echenevex	PA4
WLO1 WLO2	L'Oudar	Upstream Downstream	of the first outlet from PA5, Les Pachottes, municipality Cessy	PA5
WNR1	Nant de Rebatière	Downstream of the release outlet from PA6, Bois de sous Villars-Dame, municipality Versonnex		PA6
WLM1 WLM2	Affluent of Le Marquet	Upstream Downstream	of the outlet from PA7, municipality Ferney-Voltaire/Ornex	PA7
WN1 WN2	Le Nant	Upstream Downstream	of the outlet from PA8, municipality Ferney-Voltaire	PA8

Table I.5: Index of measuring points in the rivers and streams receiving water from the LHC and CNGS civil engineering worksites (France), weekly measurements.

Code	**River/stream**	**Measuring place**	
WPA5	L'Oudar	Inflow to a retention basin[3] of waters from the PA5 worksite and from the LHC underground and surface areas, Les Tuilières, municipality Cessy	
WLO3		Upstream	of the second outlet from PA5, municipality Versonnex
WLO4		Downstream	
WCNGS	Affluent of the Nant d'Avril	Trench receiving water from the worksite CNGS, Les Charmais, municipality Prévessin	
WPA6	Nant de Rebatière	Water in the pond receiving effluents from the PA6 worksite and from the LHC underground and surface areas, municipality Versonnex	

[3] Water from the civil engineering worksite at LHC PA5 is collected in a retention basin for decantation and then released to the river L'Oudar through dedicated drainage (southern outlet from PA5).

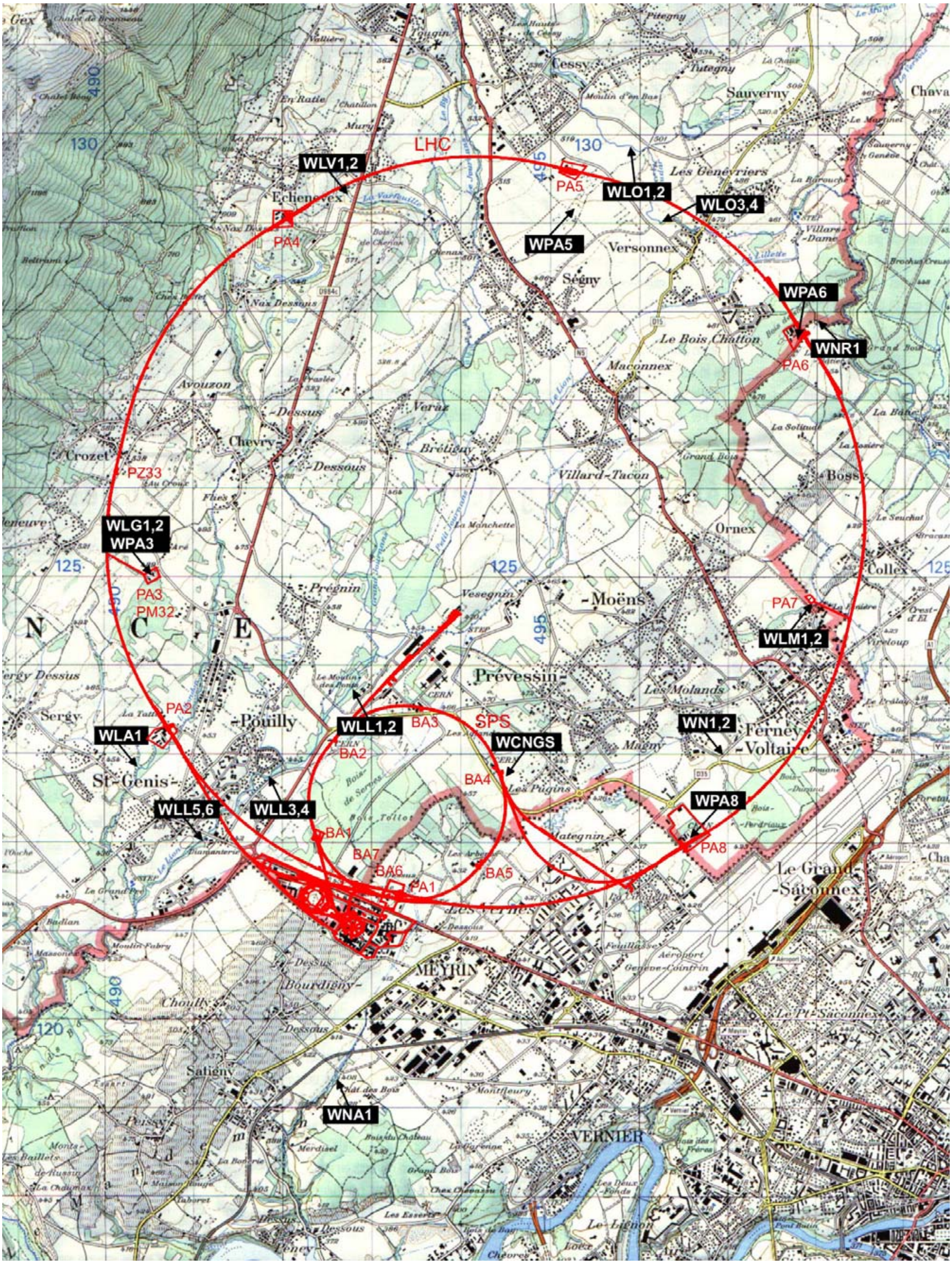


Figure I.2: Location of the routine water measuring points in Pays de Gex and the adjacent Geneva region.

2. Regulatory limits

CERN bases its regulatory limits on the Swiss and French limits for water released directly into watercourses and for the quality of water in the receiving river, which are listed in Table I.6. The limits are applied for instantaneous water measurements as well as for instantaneous and 24-hour water samples.

3. Results of measurements

The results of the water quality measurements carried out in CERN effluents and in the receiving rivers and streams are reported in this section. A summary of the non-compliance cases observed in 2003, which were linked to CERN activities, is given in Table I.7.

3.1. Monitoring of effluents

Five alarms were received at the continuous pH monitoring stations, which are located at the six main water outlets of the Meyrin and Prévessin sites. Three of them concerned the effluents released from the southeastern part of the Meyrin site into the river Nant d’Avril. These events lasted a few minutes and had a negligible impact on the river Nant d’Avril. Two other pH alarms concerned the effluents released into the river Le Lion. The first one originated from an accidental leakage of hydrochloric acid in the western area of the Meyrin site. Acid effluents (pH=3) were released from this part of the site with a flow of 30 m^3/h into the river Le Lion which had at this time an estimated flow of 3000 m^3/h. The incident lasted four hours, but thanks to the high flow of the river water, the impact on the watercourse was negligible. The second pH alarm concerned the effluents released form the Prévessin site into the river Le Lion. The alarm conditions lasted only a few minutes. The origin of the higher pH in the effluent water could not be identified. More details on these events can be found elsewhere [5]. At all six outlets, the temperature of the released effluents stayed well below the regulatory limits [6, 7].

The concentration of hydrocarbons in the water discharged from LHC PA7 and LHC PA8 stayed within normal ranges over the year 2003. The results of hydrocarbon measurements performed by the Geneva Authorities (DIAE) at the LHC PA8 site and in the receiving watercourse are listed in Table I.8. All values complied with the legal limit of 10 mg/l in effluent water [6, 7].

Three water sampling campaigns took place during the year 2003 (June, September, December) to check in more details the environmental compliance of physicochemical parameters of CERN effluent water with the regulatory limits. During each campaign, four 24-hour water samples were taken at the pH and temperature monitoring stations located on the Meyrin and Prévessin sites and one instantaneous water sample was taken in merged effluents from the BA6 and LHC PA1 sites. The results are presented in Table I.9, including the amount of water released in 2003 from the main CERN water outlets. All parameters complied with the regulations in force, except the concentration of suspended matter in samples from the northeastern part of the Meyrin site and the Prévessin site which were taken on 29 September. The samples were taken one day after rainfalls, which explains the increased concentration of suspended matter. The concentration of lead in a sample from the western part of the Meyrin site which was taken on 18 June was slightly above the limit. The origin of the higher lead concentration could not be identified.

Following an agreement between CERN and the Swiss authorities related to the elimination of PCB from the CERN site, PCB measurements were carried out on two instantaneous water samples taken on 9 April in the relevant water outlets. The results are given in Table I.9 and show that the PCB concentrations were below the Swiss legislation [8].

3.2. Measurements in the river Nant d'Avril

The variations of pH, temperature, concentration of dissolved oxygen and conductivity measured in the river Nant d'Avril downstream CERN release points are shown in Figure I.3. All measured values complied with the regulatory limits [6].

The values of pH measured during 2003 showed minor fluctuations, which are due to natural conditions. As shown Figure I.4, the increase of the water temperature in early spring, linked to the restart of CERN accelerators after the annual shutdown, is less important than in the past because of the restructuring of the SPS cooling-water system and the LEP shutdown in 2001. In addition to CERN measurements, continuous temperature measurements were performed by the *Institut Forel* (University of Geneva) on the behalf of the Swiss authorities. The average temperature of the Nant d'Avril found to be 14.8 C in 2003 and 15.2 °C in 2002, compared to 17.1°C in 2000 [9]. The cause of the higher water temperature measured at the end of November could not be identified. A slight decrease of concentrations of dissolved oxygen in summer occurred due to the increased water temperature and the presence of microorganisms in the water, which use oxygen to degrade organic matter. The cause of the higher conductivity value measured at the beginning of February may be linked to the input of salt, which was washed down from roads. A decrease of the conductivity could be correlated with precipitation periods. Rainwater, which has a low mineral content, dilutes the river water when the input of meteoric water is important.

3.3. Measurements in the river Le Lion

The variations of pH, temperature, concentration of dissolved oxygen and conductivity upstream and downstream of CERN release points along the river Le Lion are shown in Figure I.5. All values complied with the regulatory limits [7, 10], except the concentrations of dissolved oxygen measured in summer at the points WLL3, WLL4, WLL5 and WLL6, which were significantly lower than the guideline value. This was not due to CERN effluents but rather to a high amount of natural and/or anthropic organic matter already present in the river water upstream of the CERN outlets, and to unusually hot and dry weather conditions that kept the dissolved oxygen concentrations at low levels. Fish mortality was observed for the first time since 1998 along the surveyed watercourse section (mainly trouts).

As indicated in Table I.7, discharge of sewage water into the river Le Lion was observed during a weekly visit carried out in November at the outlet of the Prévessin Site. The sewage network downstream the CERN Prévessin site overflowed during heavy precipitations. The impact of the discharges on the river water quality was negligible.

3.4. Measurements in the rivers and streams receiving water from the LHC sites

The variations of pH, temperature, concentration of dissolved oxygen and conductivity measured around the seven LHC sites PA2 – PA8 are shown in Figure I.6. The data show the quality of river water downstream of the outlets from the sites. A measurement done upstream of an outlet is only reported if a significant difference between the parameters before and after the outlet is observed. All values complied with the regulatory limits [7, 10] except the low concentrations of dissolved oxygen measured at WLM2 during summertime, which was not due to CERN effluents (the same cause as explained in Section 3.3). The stream takes its source water in a swamp and may be rich in organic matter. The dissolved oxygen lowers with increased water temperature and is consumed by microorganisms present in the water, which use oxygen to degrade the organic matter.

As indicated in Table I.7, traces of mineral oil in effluents released from PA3 were observed on 30 April. CERN specialists intervened immediately to retain the oil on the site. Corrective measures were taken to clean-up the drains in the PA3 LHC underground area where the pollution originated. The source could not be identified. The concentration of dissolved oxygen reached the critical level of < 2 mg/l O_2 in the water of the pond located at LHC PA6 due to the dry and hot weather conditions of the summer 2003 (see Figure I.8). The pond was supplied with raw water until acceptable oxygen concentrations were reached. No fish mortality was observed (species living in the pond are carps, pikes and roaches). Traces of hydrocarbons were observed in the stream Nant de Rebatière (measuring point WNR01) on 28 May. Cause of this minor pollution was a problem in the hydrocarbon absorption system placed in a drain for surface water at the PA6 site network. The impact on the stream Nant de Rebatière was negligible and all necessary corrections were taken by the responsible units to prevent a similar incident to happen again. As indicated in Table I.7, alkaline and turbid effluents were released into the affluent of Le Marquet from the LHC site PA7 on 21 May. The slightly polluted effluents did not affect the water quality of the receiving stream because of their very low flow-rate. The cause of the pollution was linked to minor civil-engineering activities in the LHC PA7 underground areas.

2.5. Measurements in the rivers and streams receiving water from the LHC and CNGS civil engineering worksites

The variations of pH, temperature, concentration of dissolved oxygen and conductivity of the water in the river L'Oudar, before and after the release point of the LHC civil engineering worksite at PA5 are shown in Figure I.7. All measured values complied with the regulatory limits [7, 10]. The fluctuations of the measured parameters overs the year 2003 were due to natural conditions.

The variations of pH, temperature, concentration of dissolved oxygen and conductivity of the water in the pond receiving water from the PA6 civil engineering worksite are shown in Figure I.8. On 22 January a pH value of 9.9 was measured in the water released from the worksite into the pond, due to a failure of the neutralization system. The pH value in the pond close to the outlet of the worksite exceeded the regulatory limit [7] for almost two weeks. No obvious impact on the biotope pond was observed. As indicated in Table I.7 and shown in Figure I.8 the stagnant water and falling water level of the pond due to the very hot summer caused the low concentrations of dissolved oxygen. On 5 August, traces of mineral oil were observed in the effluents released from the worksite directly into the stream Nant de Rebatière (through a network which does not lead the water into the pond). CERN specialists intervened to retain the oil on the PA6 site. The impact on the stream Nant de Rebatière was negligible. The cause of the pollution was not identified. On 25 August, the contractor working on the LHC PA6 worksite accidentally pierced a 1 m^3 tank partially filled with used oil (casing, engine oil…). About 200 litres of oil spread out on the ground close to the pond and flowed partially into the water of the pond. The contractor and the CERN responsible units intervened to retain the oil, clean-up the area and ensure a proper elimination of polluted material (oil-water mixture, polluted concrete, sediments, reeds…). The water outlet from the pond to the stream Nant de Rebatière was blocked after the incident to prevent the pollution of the stream. As indicated in Table I.10, the measurements carried out on water samples and sediment samples taken in the pond at the areas most affected by the incident showed that the hydrocarbon concentrations remained within acceptable levels and that the affected areas of the pond were not to be considered as a pollution source for the stream Nant de Rebatière [11]. In addition, no obvious impact on the biotope pond was observed.

The variations of pH, temperature, concentration of dissolved oxygen and conductivity of the water in the trench receiving water from the CNGS civil engineering worksite (affluent of the Nant d'Avril) are shown in Figure I.9. At the end of February, the neutralisation and decantation system of the CNGS worksite broke down (see Table I.7), increasing the pH of the water in the trench. The necessary corrective measures were taken immediately by the contractor to improve and secure the effluent treatment system. The higher water temperature and lower dissolved oxygen concentrations were due to the hot and dry weather conditions during the summer 2003. The slightly lower pH and high conductivity measured in the water in the middle of June was probably due to disturbances of the neutralization system (usage of hydrochloric acid).

Table I.6: Swiss and French limits in effluent water and for the quality of the water in receiving rivers.

	Limits for CERN effluents		**Limits for the quality of river water after CERN outlets**	
Parameter	**Swiss limits (OEaux[4])**	**French limits (A. 02.02.98[5])**	**Swiss limits (OEaux)**	**French limits[6]** *(“Eaux salmonicoles”)*
Temperature	30°C	30°C	<25°C and the difference between the temperatures of river water before and after the outlet should be less than 3°C	<21.5°C and the difference between the temperatures of river water before and after the outlet should be less than 1.5°C[7]
pH	6.5-9	5.5-8.5	No alteration in river water before and after the outlet	Maintain a pH between 6 and 9 after the outlet
Conductivity	-	-	Not defined	3000 μS/cm[8]
Dissolved O_2	-	-	No reduction of O_2	50% of values measured during one month ≥9 mg/l 100% of values measured during one month ≥7 mg/l[9]
Turbidity	-	-	No turbidity (except during rainfalls)	35 NTU (Nephelometric turbidity unit)[8]
Suspended matter	20 mg/l	35 mg/l	No forming of mud	25 mg/l[9]
COD (Chemical oxygen demand)	-	125 mg/l O_2	-	30 mg/l O_2[8]
DOC (Dissolved organic carbon)	10 mgl/ C	-	1-4 mg/l C	7 mg/l C[8]
Ammonium	2 mg/l N	-	0.2 mg/l N	1 mg/l NH_4
Nitrites	0.3 mg/l N	-	-	0.01 mg/l NO_2[9]
Nitrates	-	-	5.6 mg/l N	10 mg/l NO_3[8]
Chlorides	-	-	100 mg/l Cl^-[10]	125 mg/l Cl^-[8]
Copper	0.5 mg/l Cu	0.5 mg/l Cu	0.005 mg/l Cu	0.04 mg/l Cu dissolved[9]
Zinc	2 mg/l Zn	2 mg/l Zn	0.02 mg/l Zn	0.3 mg/l Zn
Iron	2 mg/l Fe[10]	5 mg/l Fe + Al	1 mg/l Fe dissolved[10]	-
Aluminium	10 mg/l Al[10]	5 mg/l Al + Fe	0.1 mg/l Al dissolved[10]	0.2 mg/l Al[8]
Lead	0.5 mg/l Pb	0.5 mg/l Pb	0.01 mg/l Pb	0.01 mg/l Pb[8]
Cadmium	0.1 mg/l Cd	0.2 mg/l Cd	0.2 μg/l Cd	0.37 μg/l Cd[8]
Nickel	2 mg/l Ni	0.5 mg/l Ni	0.01 mg/l Ni	0.02 mg/l Ni[8]
Cyanides	0.1 mg/l CN^-	0.1 mg/l CN^-	-	7.5 μg/l CN^-[8]
Total hydrocarbons	10 mg/l	10 mg/l	0.05 mg/l[10]	-
Total PCBs (Polychlorinated biphenyls)	0.1 μg/l	0.05 mg/l	-	0.01 μg/l[8]

[4] Ordonnance sur la protection des eaux, OEaux 814.201, Octobre 1998.
[5] Arrêté du 2 février 1998 relatif aux prélèvements et à la consommation d’eau ainsi qu’aux émissions de toute nature des installations classées pour la protection de l’environnement soumises à autorisation.
[6] Décret n°91-1283 du 19 décembre 1991 relatif aux objectifs de qualité assignés aux cours d’eau, sections de cours d’eau, canaux, lacs ou étangs et aux eaux de la mer dans les limites territoriales.
[7] Arrêté modifié du 20 novembre 1979 relatif à la lutte contre la pollution des eaux (application du décret n°78-218 du 23 février 1973).
[8] Guideline value taken from the French national water quality evaluation system *SEQ-EAU (green quality class).*
[9] Guideline value (quality objective) from the French Décret n°91-1283 du 19 décembre 1991.
[10] Guideline value from the Swiss *Ordonnance sur le déversement des eaux usées* (no more in force).

Table I.7: Summary of the non-compliance cases observed in 2003, which were linked to CERN activities.

	River of concern	Date in 2003	Observed non-compliance	Origin	Environmental impact
MEYRIN AND PRÉVESSIN SITES	Nant d'Avril	30 September	Discharge of alkaline and turbid effluents from the southeastern part of the Meyrin site (pH alarm of 10)	Civil engineering (close to computer centre)	Negligible
		9 October	Discharge of alkaline and turbid effluents from the southeastern part of the Meyrin site (pH alarm of 10)	Civil engineering (close to computer centre)	Negligible
		4 December	Discharge of alkaline, turbid and foamy effluents from the southeastern part of the Meyrin site (pH alarm of 9.3)	Unknown	Negligible
	Le Lion	17 February	Discharge of acid effluents from the western area of the Meyrin site (pH alarm of 3)	Accidental leakage to drain for surface water during delivery of hydrochloric acid in the demineralized water plant	Negligible
		27 November	Discharge of sewage water from the Prévessin site	Sewage network blocked downstream to CERN site, leakage to drain for surface water	Negligible
		18 December	Discharge of alkaline effluents from the Prévessin site (pH alarm of 9.4)	Unknown	Negligible
LHC PA2-PA8	Affluent of L'Allondon	30 April	Traces of mineral oil in effluents released from the LHC PA3 site	Neglected maintenance of the drains in the PA3 LHC underground area	Negligible
	Affluent of Nant de Rebatière (pond at LHC PA6)	24 April	Concentration of dissolved O_2 < 6mg/l in the water of the pond located at LHC PA6	No natural water supply	Negligible
		2 July	Concentration of dissolved O_2 < 2mg/l in the water of the pond located at LHC PA6	No natural water supply	Medium
	Nant de Rebatière	28 May	Traces of mineral oil in effluents released from the LHC PA6 site	Neglected maintenance of hydrocarbon absorption system in drain for surface water	Negligible
LHC/CNGS WORKSITES	Affluent of the Nant de Rebatière (pond at PA6)	22 January	Discharge of alkaline effluents from the LHC PA6 worksite into the pond located at LHC PA6 (pH of 9.9)	Failure of the neutralization system	Negligible, restricted to the CERN site
		25 August	Mineral oil in the water of the pond located at LHC PA6	Accidental leakage of 200l of used oil into the pond (casing oil, engine oil…)	Medium
	Nant de Rebatière	5 August	Traces of mineral oil in effluents released from the LHC PA6 worksite	Accidental leakage into drain for surface water	Negligible
	Affluent of Le Marquet	21 May	Discharge of alkaline and turbid effluents from the LHC PA7 site	Civil engineering in the LHC PA7 underground area	Negligible
	Affluent of the Nant d'Avril	26 February	Discharge of alkaline and turbid effluents from the CNGS worksite (pH of 10)	Failure of the water treatment plant	Negligible

Table I.8: Concentrations of total hydrocarbons as measured by the Geneva authorities (legal limit of 10 mg/l in effluent water).

Sampling date in 2003	Concentration of total hydrocarbons (mg/l)	
	After oil-water separator (PA8, France)	Le Nant (after outlet from PA8, France)
20 March	0.05	Below the detection limit
10 June	0.02	Below the detection limit
29 September	Below detection limit	Below the detection limit
4 December	1.47	1.49

Table I.9: Results of the water-measuring campaigns in CERN effluents carried out during the year 2003.

Receiving river	**Nant d'Avril (CH)**				**Le Lion (F)**		
Concentration limit and sampling point	***CH-limit***	NE-Meyrin	SE-Meyrin	PA1/BA6	***F-limit***	W-Meyrin	Prévessin
pH	*6.9-9*	8-8.1	8.1-8.5	8.2	*5.5-8.5*	8.1	8
Conductivity	-	330-400	324-1167	294-314	-	614-665	320-479
Turbidity (NTU[11])	-	<1-3	<1->100	<1-2	-	2	<1-64
Suspended matter (mg/l)	*20*	<1-1.4	<1-110	<1-3.7	*35*	2.1	<1-40.1
COD (mg/l O_2)[12]	-	6	7	7	*125*	8	10
DOC (mg/l C)[13]	*10*	<5-13	<5	<5	-	<5	<5
Ammonium (mg/l N)	*2*	<0.2	<0.2	<0.2	-	<0.2	<0.2
Nitrites (mg/l N)	*0.3*	<0.02-0.04	<0.02-0.05	<0.02-0.02	-	0.02-0.03	<0.02-0.02
Chlorides (mg/l Cl)	-	15	26	10	-	21	16
Copper (mg/l Cu)	*0.5*	<0.1	<0.1	<0.1	*0.5*	<0.1	<0.1
Zinc (mg/l Zn)	*2*	0.1-0.4	0.2-0.3	0.2-0.3	*2*	0.1-0.2	0.2
Iron (mg/l Fe)	*2*	<0.1	<0.1	<0.1	*5 (Fe+Al)*	<0.1	<0.1
Aluminium (mg/l Al)	*10*	<0.02	<0.02	<0.02	*5 (Al+Fe)*	<0.02	<0.02
Lead (mg/l Pb)	*0.5*	<0.1	0.12-0.16	<0.1	*0.5*	<0.1-0.53	<0.1
Cadmium (mg/l Cd)	*0.1*	<0.05	<0.05	<0.05	*0.2*	<0.05	<0.05
Nickel (mg/l Ni)	*2*	<0.1-0.2	<0.1	<0.1-0.1	*0.5*	<0.1-0.1	<0.1-0.1
Cyanides (mg/l CN^-)	*0.1*	<0.01	<0.01	<0.01	*0.1*	<0.01	<0.01
Total hydrocarbons (mg/l)	*10*	0.9	0.5	1.1	*10*	0.7	2.1
Total PCBs[14] (μg/l)	*0.1*	0.012	0.017	-	*50*	-	-
Water released in 2003 (10^6 m^3)		0.44	2.1	0.15[15]		0.131	0.31

Table I.10: Concentration of the total hydrocarbons in water (W-) and sediment (S-) samples taken in the pond located on the CERN LHC PA6 site.

Sample code	**Sample location**	**Concentration of total hydrocarbons**		**French limits [7, 11]**
		16 September	22 September	
W-B1	South-east border (close to the source)	3.0 mg/l	1.4 mg/l	
W-B2	North-east border	1.0 mg/l	<0.5 mg/l	10 mg/l
W-B3	West border	1.4 mg/l	<0.5 mg/l	
S-B1	South-east border (close to the source)	160 mg/kg	230 mg/kg	VDSS[16]: 2500 mg/kg

11 Nephelometric turbidity unit.
12 Chemical oxygen demand.
13 Dissolved organic carbon.
14 Polychlorinated biphenyls.
15 Including only the deconcentration water from the SPS cooling loop.
16 Valeur de définition source-sol: defines if the soil has to be considered as a pollution source.

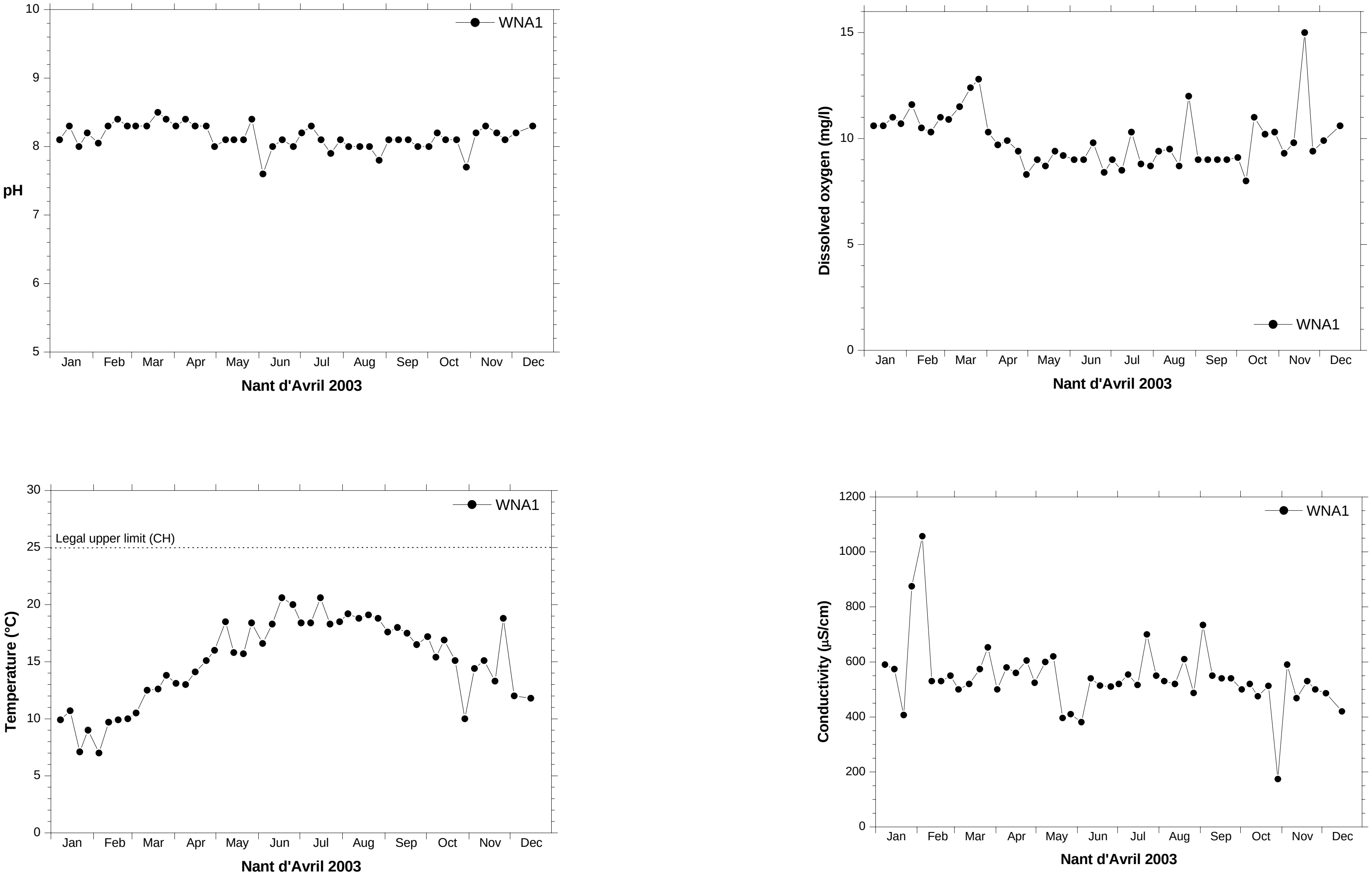


Figure I.3: Results of measurements performed in the river Nant d’Avril (CH).

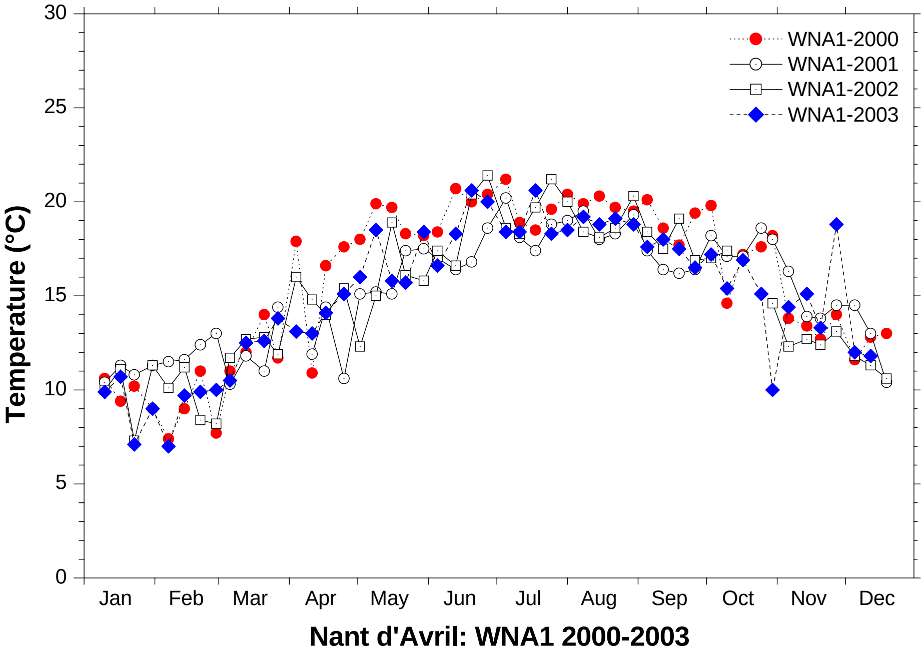


Figure I.4: Results of the temperature measurements performed at WNA1 (CH) from 2000 to 2003.

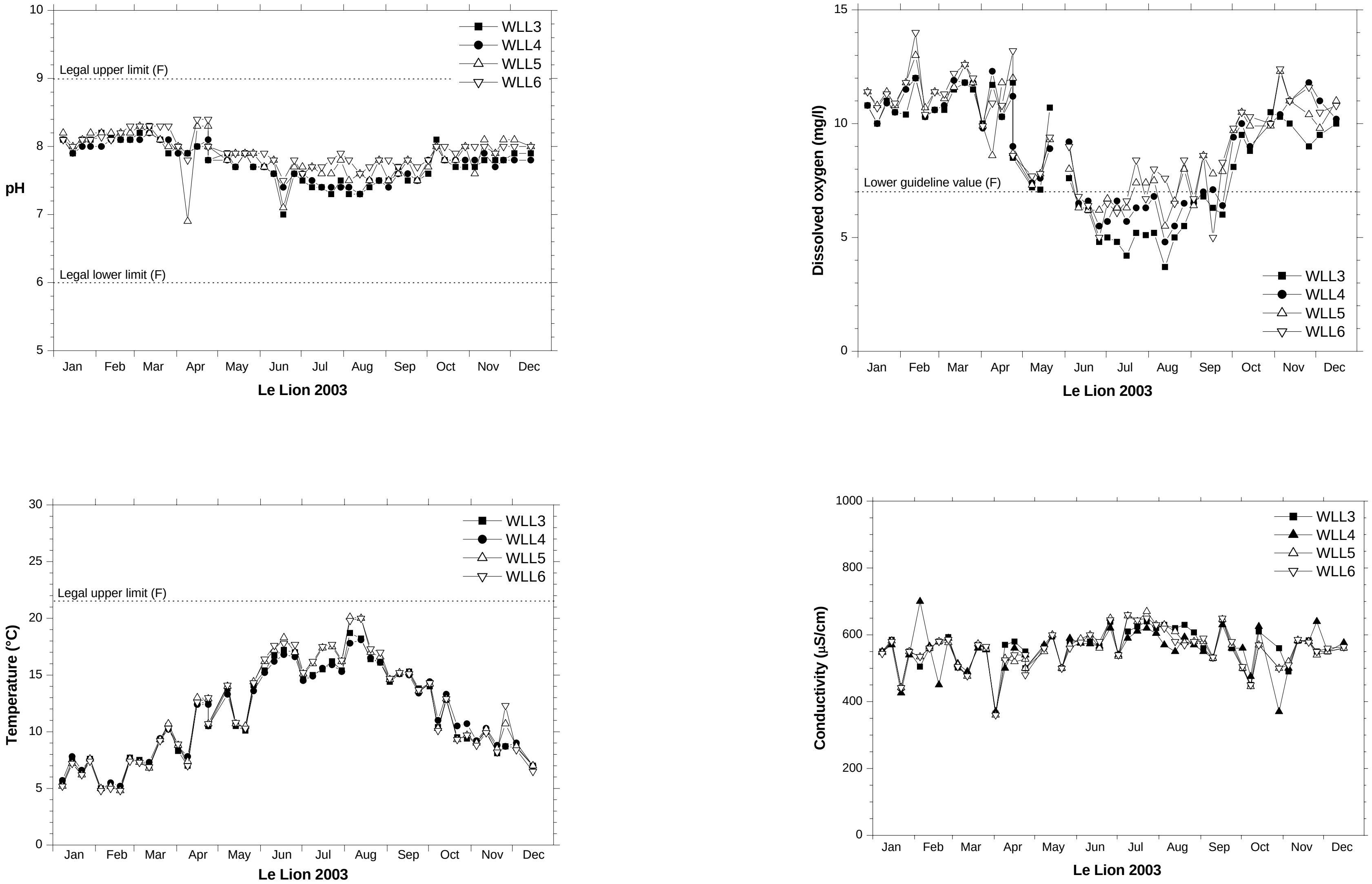


Figure I.5: Results of measurements performed in the river Le Lion (F).

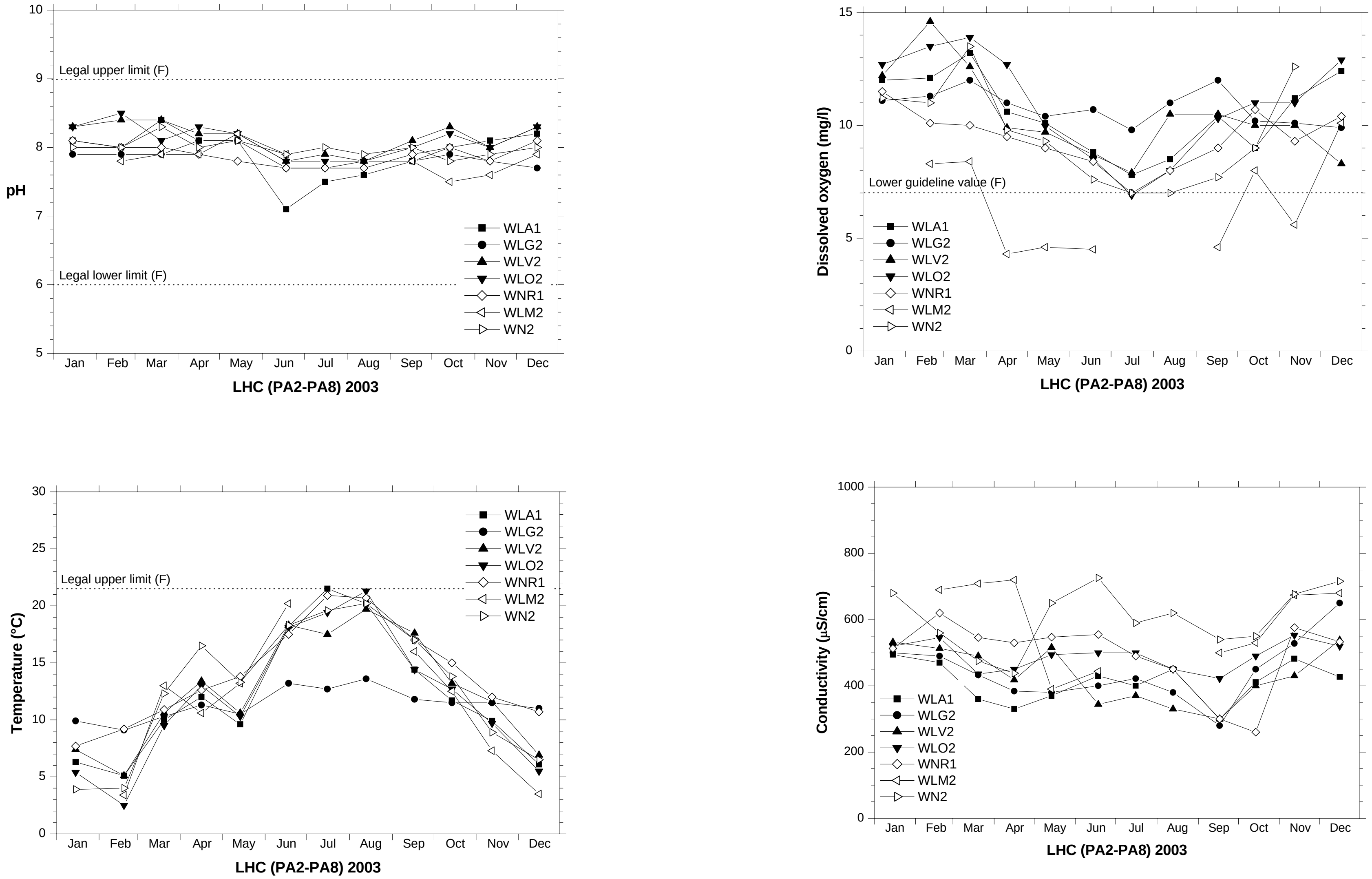


Figure I.6: Results of measurements performed around the LHC sites PA2–PA8 (France). Data are missing for the point WLM2 because the water level was too low to perform the measurements.

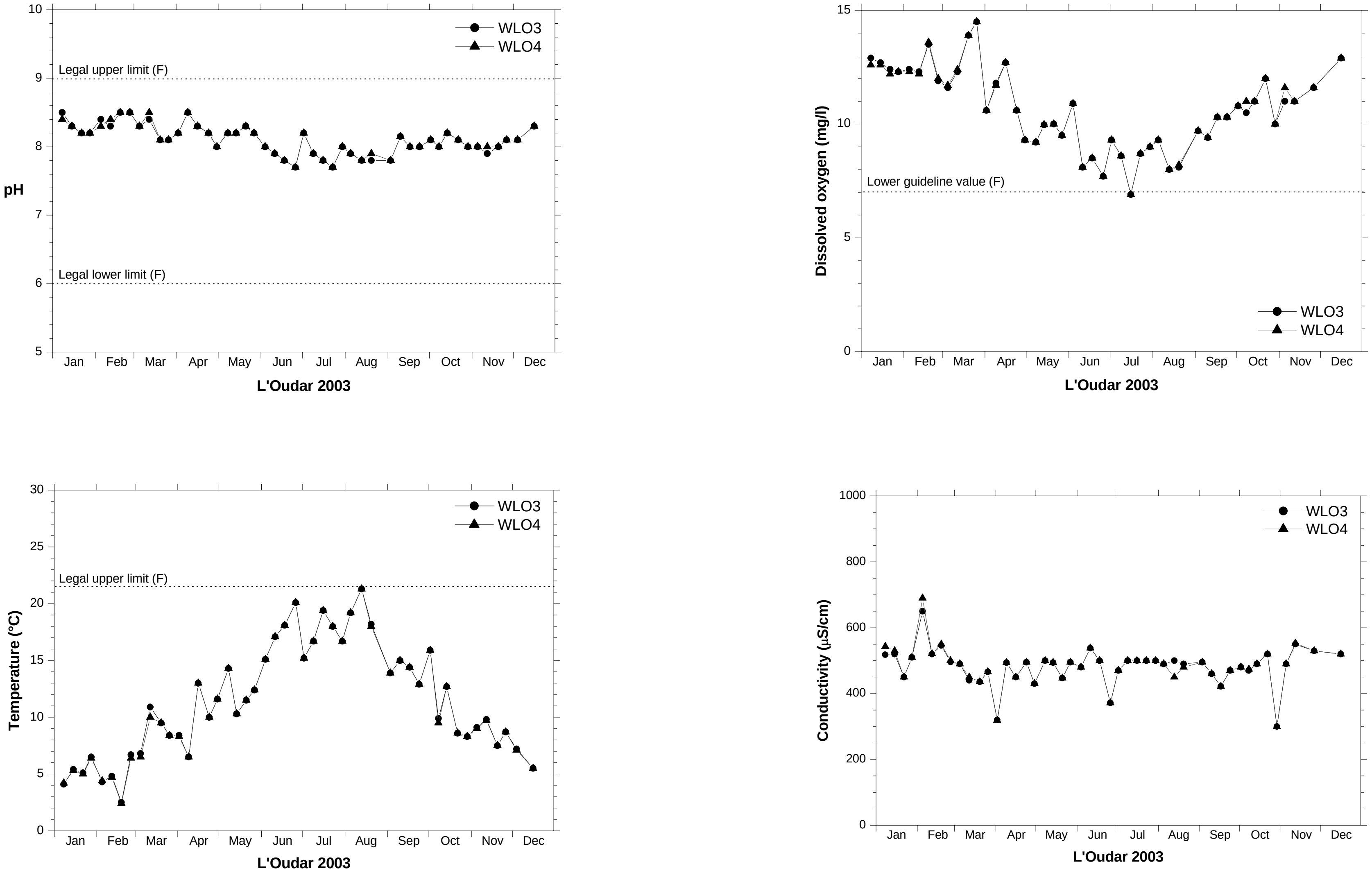


Figure I.7: Results of measurements performed in the river L'Oudar (F).

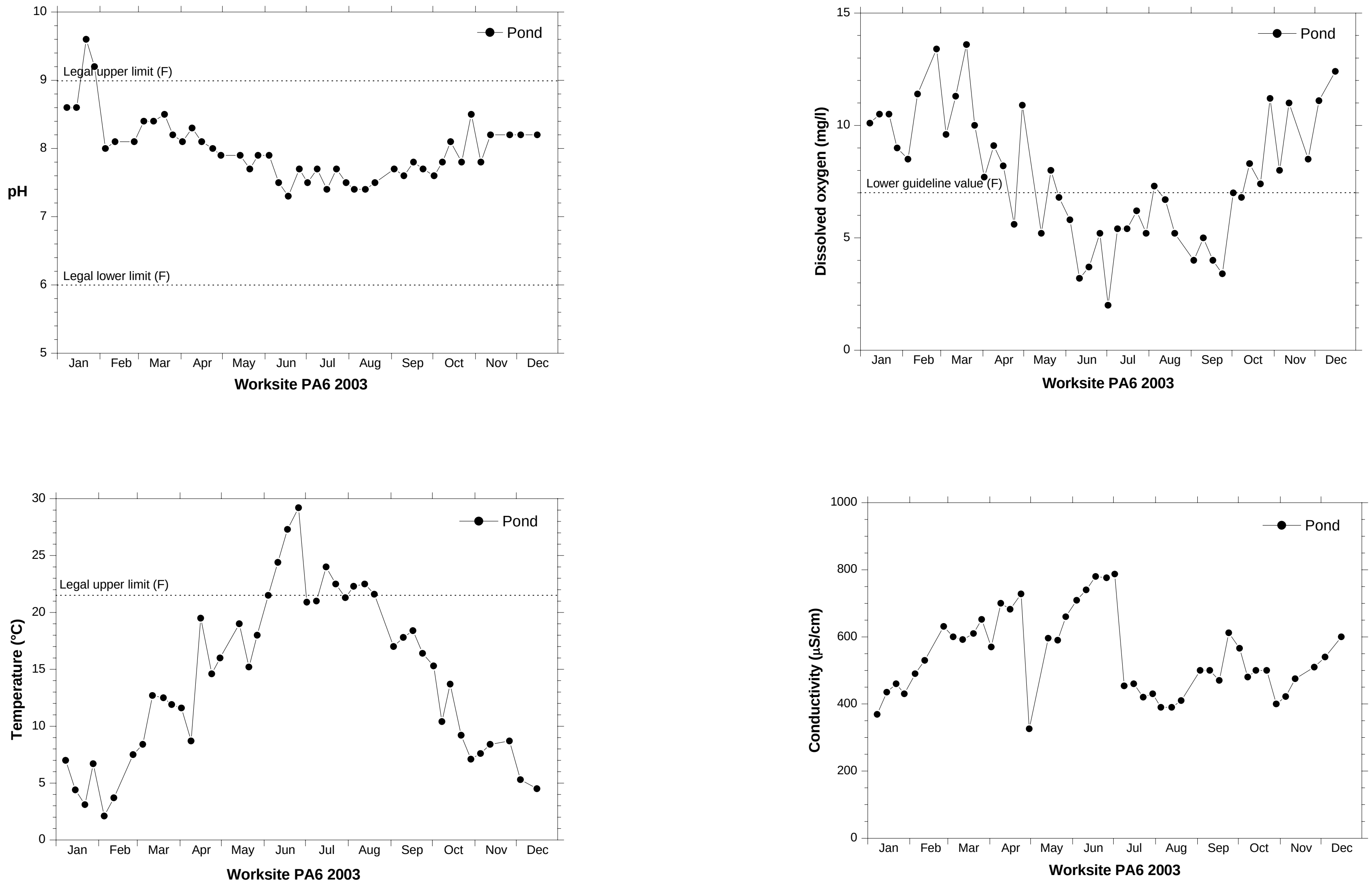


Figure I.8: Results of measurements performed in the pond receiving water from the LHC civil engineering worksite at PA6 (F).

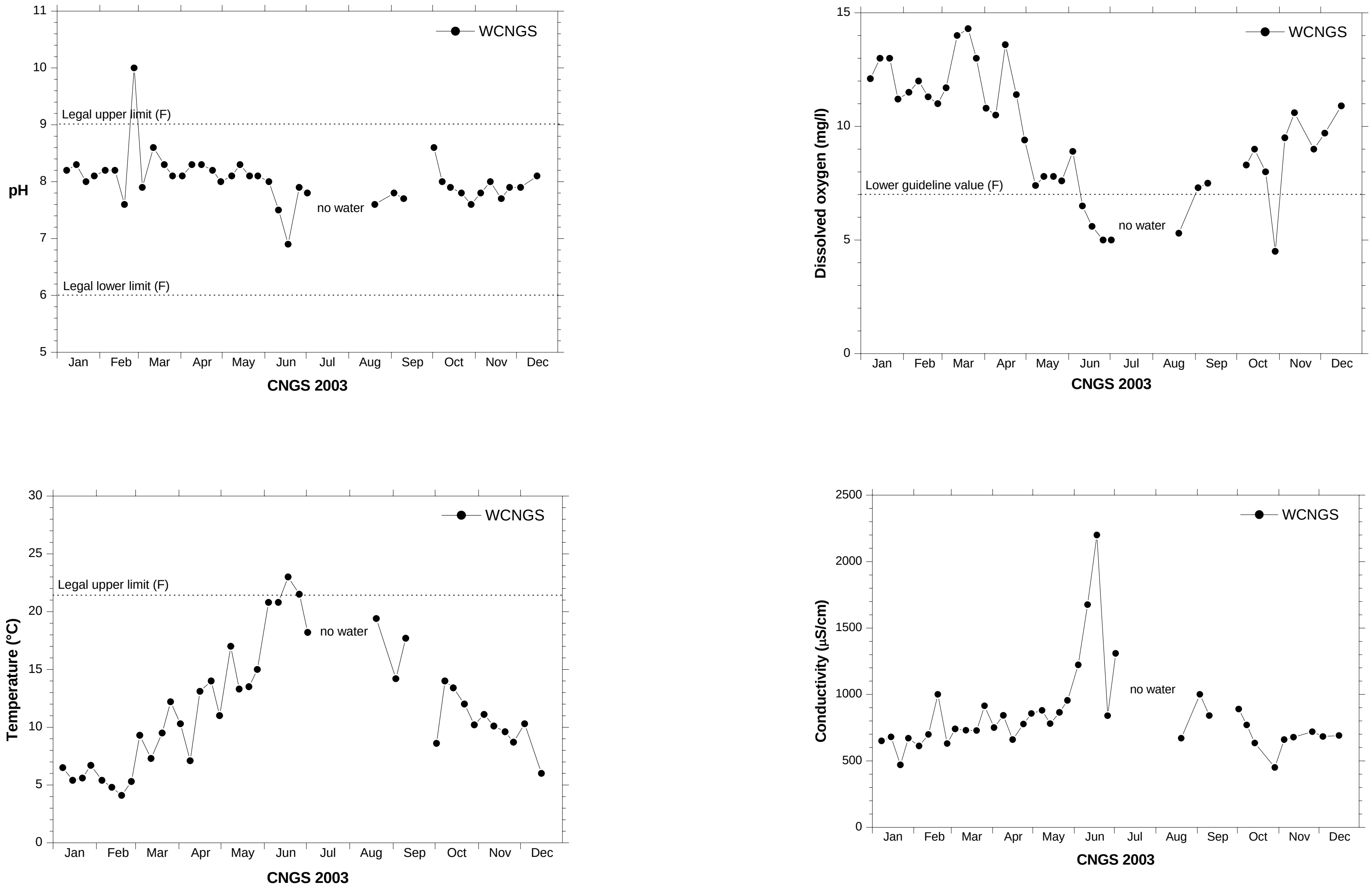


Figure I.9: Results of measurements performed in the stream receiving effluents from the CNGS civil engineering worksites (F). Data are missing because the water level was too low to perform the measurements.

II AIR QUALITY MEASUREMENTS

1. Monitoring programme

1.1. Monitoring stations

Air quality measurements at CERN include continuous measurements of concentrations of ozone and nitrogen oxides (NO and NO_2) in the ambient air and sporadic monitoring in ventilation outlets of accelerator facilities. All monitoring stations, including two off-site air monitoring stations in Maisonnex and in Cessy are equipped with commercial monitors to measure these parameters. The station Maisonnex is located in a suburban to rural environment, downwind of the CERN Meyrin site (433 m a.s.l.). The station Cessy is located in a rural environment in the cross-wind direction from LHC PA5 and measures background concentrations (530 m a.s.l.). Both stations are sampling air from a height of 3 m above the ground. During the year 2003, sporadic monitoring was carried out at the air extraction point of the transfer tunnel TT10 from the PS to the SPS accelerator. The locations of the air monitoring stations are presented in Figure II.1.

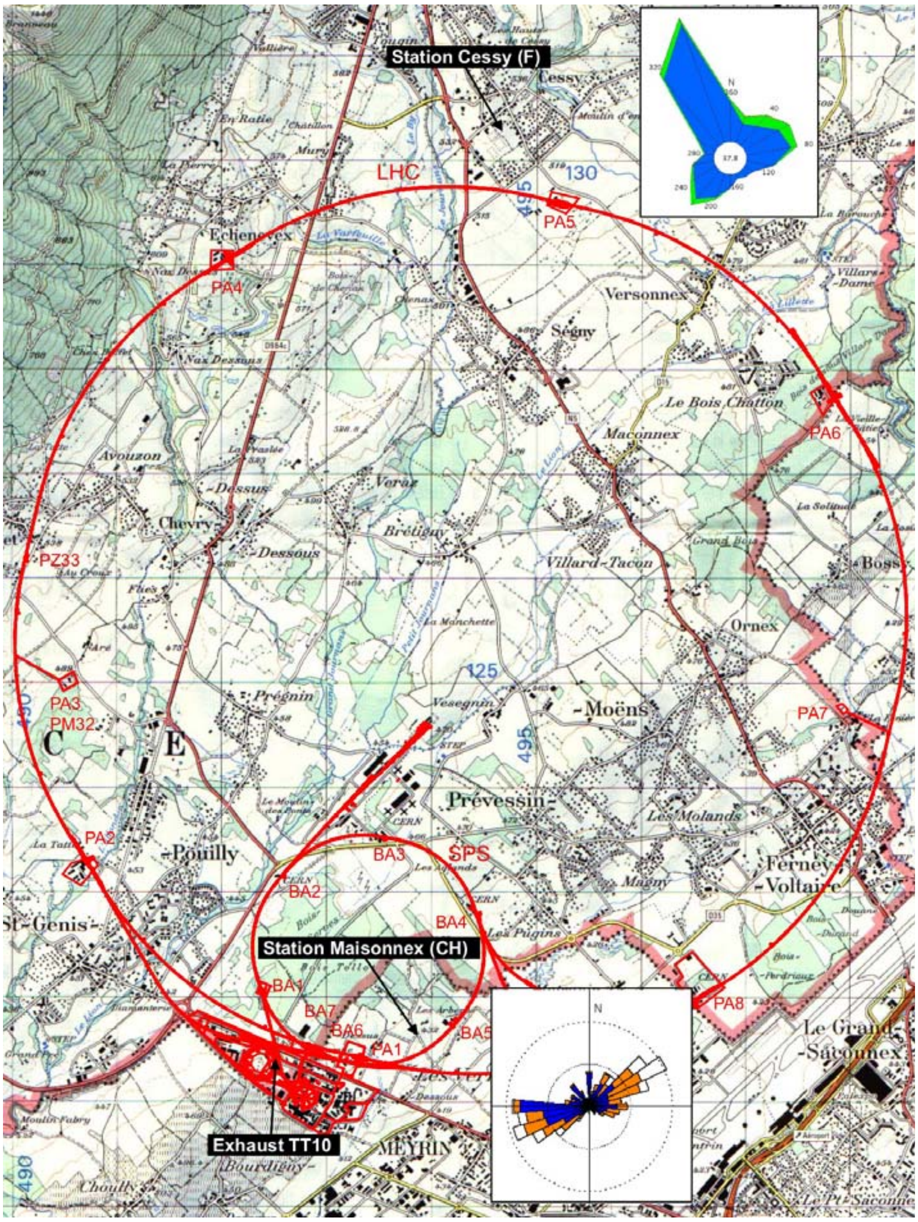


Figure II.1: Location of the CERN air monitoring stations.
(Wind roses provided by Météo France – Cessy, Météo Suisse – Geneva Aeroport)

Ozone and nitrogen oxides (NO and NO_2) are the parameters monitored in the air monitoring stations since they may be produced in CERN accelerator facilities and released into the atmosphere through ventilation systems. The excitation of oxygen molecules due to air ionisation can lead to the production of ozone. Excited oxygen molecules can also react with nitrogen in air and form nitrogen oxides [12, 13].

1.2. Instrumentation

The used commercial instruments are listed in Table II.1. The ozone monitors use ultraviolet absorption spectrometry to measure ozone concentrations directly and continuously. Monitors are periodically calibrated by the supplier. In addition, the ozone monitors are adjusted by using a calibrated ozone-generator (a service provided by the *Service scientifique de l'environnement,* DIAE, Geneva). The NO_x monitors are based on chemiluminescence to detect NO directly, and NO_2 in the same way as NO after its reduction to NO in a catalytic furnace. The calibration of the nitrogen oxides monitors is monthly checked at CERN using two bottles with fixed NO concentrations (48 ppm and 480 ppm) and a precision gas diluter (HORIBA SGGU-514). The gas mixture is diluted in the ratio of 1:1’026 in order to obtain low-level concentrations corresponding to the measuring range. The precision gas diluter enables setting the zero point by producing NO-free air.

Table II.1: Main characteristics of instruments used in CERN air monitoring stations.

No.	Instrument type/SN	Manufacturer	Parameter measured	Range (ppm)
1	$O_3$41M (477)	Environnement S.A.	Ozone	0–10
2	$O_3$41M (639)	Environnement S.A.	Ozone	0–10
3	$O_3$41M (1413)	Environnement S.A.	Ozone	0–10
4	AC31M (478)	Environnement S.A.	NO/NO_x	0–10
5	AC31M (709)	Environnement S.A.	NO/NO_x	0–10
6	AC31M (1434)	Environnement S.A.	NO/NO_x	0–10

1.3. Data acquisition and analysis

Air monitoring stations for ambient air have been operational in Maisonnex and Cessy since 1986 [1]. During the period 1986–1988, data were only analysed for three months (January, June and September). These months were chosen to reflect seasonal variations, including a period of high values of ozone and low values of nitrogen oxides (summer), and a period of high values of nitrogen oxides and low values of ozone (winter). Since February 1989, data are collected continuously using dedicated data acquisition systems. In October 1998, a prototype of wireless remote readout of the NO_x and ozone monitors was installed at the station Maisonnex. The station Cessy was equipped with remote readout system in June 1999. Thanks to the remote readout system, the monitors can be checked at will and failures identified in real time.

In accordance with the existing standards [14], data are collected every 5 seconds and averaged every 30 minutes. Data are collected continuously, except during periods of maintenance or electrical power failure. The data are recorded as parts per billion (ppb), and converted to micrograms per cubic meter ($\mu g/m^3$) [14]. They are then analysed according to the regulatory limits adopted by CERN [3]. Measurements are compared to those of the Swiss authorities carried out in the Geneva region by ROPAG (*Réseau d’Observation de la Pollution Atmosphérique de Genève*). For information, the Swiss limits for nitrogen dioxide and ozone immissions (OPair) are given in Table II.2 and the French limits [15] for ambient air quality are given in Table II.3.

Table II.2: Swiss limits for nitrogen dioxide and ozone concentrations in ambient air [3].

Gas	Immission limit (μg/m^3)	Statistics
Ozone	100 120	98% of average half-hour values must be less than or equal to 100 μg/m^3 monthly Average hourly value must not exceed 120 μg/m^3 more than once per year
Nitrogen dioxide (NO_2)	30 100 80	Annual average (arithmetic mean) must not exceed 30 μg/m^3 95% of half-hour annual values must be less than or equal to 100 μg/m^3 Average 24-hour values must not exceed 80 μg/m^3 more than once per year

Table II.3: French limits for nitrogen dioxide and ozone concentrations in ambient air [15].

	Guidance value for human protection (μg/m^3)	Statistics
Quality objective for ozone immissions	110	Average over a period of 8 hours must be less or equal to 110 μg/m^3
Immission limit for nitrogen dioxide	200	Percentile-98 of half-hour values over the reference year must be less than or equal to 200 μg/m^3

2. Results of measurements

2.1. Trends in 2003

The number of days with data and the immission statistics calculated according to the regulatory limits [3] for the nitrogen dioxide (NO_2) and ozone (O_3) concentrations in Maisonnex and Cessy are given in Table II.4. Missing data are due to temporary instrumentation failures, or to electrical power cuts at the monitoring stations.

The percentages of half-hour average NO_2 immissions measured at CERN were below the limit in 2003. As shown in Table II.4 and Figure II.2, the daily average immission limit of 80 μg/m^3 for NO_2 concentration was never surpassed. The data illustrated in Figure II.2 reflect seasonal variations with NO_2 concentration increasing in the wintertime, when CERN accelerator facilities are shut down.

The percentages of half-hour average ozone concentrations measured at CERN, which should be less than or equal to 100 μg/m^3 98% of the time within one month, are given in Table II.4. The ozone concentrations exceeded the acceptable level during the exceptionally hot and dry summer months, especially at the station Cessy. The number of instances when the average hourly immission limit of 120 μg/m^3 was exceeded for ozone is much higher in Cessy than in Maisonnex for the year 2003. This limit should not be surpassed more than once per annum. The data illustrated in Figure II.3 reflect seasonal variations with O_3 concentration increasing in the summertime. The high concentration of ozone during summertime is a well-known phenomenon especially in rural areas [16] and it is not linked to CERN accelerator operation. The nitrogen oxides and volatile organic compounds (VOC) concentrated in the air react under sunlight to produce ozone (photochemical process). Therefore, the ozone concentrations reach their peak in summer when the sunshine is at its maximum. The ozone concentrations are lower in urban areas than in rural areas because the nitrogen monoxide (NO) present in higher concentrations in urban areas reacts immediately with ozone concentrated in air ($NO + O_3 \rightarrow NO_2 + O_2$). In this way, ozone is decomposed in areas where emissions of nitrogen oxides are higher.

The monthly averages of nitrogen dioxide and ozone concentrations in Maisonnex and Cessy are shown in Figure II.4. The data reflect the typical seasonal and regional variation: nitrogen dioxide concentrations higher in the wintertime (heating and adverse dispersion condition) and ozone concentrations higher in the summertime (sunshine).

Table II.4: Immission statistics calculated according to the regulatory limits [3] for nitrogen dioxide and ozone concentrations in Maisonnex and Cessy.

	Maisonnex						**Cessy**					
		NO_2			O_3			NO_2			O_3	
Month in 2003	Days with data	(1)	(2)	Days with data	(3)	(4)	Days with data	(1)	(2)	Days with data	(3)	(4)
January	30	100	0	30	100	0	31	100	0	31	100	0
February	28	100	0	28	100	0	27	100	0	27	100	0
March	30	100	0	30	100	0	30	100	0	30	96	10
April	30	100	0	30	98	0	30	100	0	30	90	18
May	30	100	0	30	100	0	31	100	0	29	93	3
June	17	100	0	17	99	0	19	100	0	15	79	23
July	28	100	0	28	95	1	4	-	-	26	63	127
August	21	100	0	21	100	0	21	100	0	30	51	235
September	25	100	0	27	100	0	30	100	0	30	93	30
October	31	100	0	31	100	0	31	100	0	27	100	0
November	30	100	0	30	100	0	27	100	0	30	100	0
December	0	-	-	0	-	-	27	100	0	31	100	0

(1) % of half-hour NO_2 values < 100 $\mu g/m^3$
(2) number of cases when 24-hour NO_2 values > 80 $\mu g/m^3$
(3) % of half-hour O_3 values < 100 $\mu g/m^3$
(4) number of cases when hourly O_3 values > 120 $\mu g/m^3$

2.2. Long term trends

The annual averages of nitrogen dioxide and ozone concentrations at the station Maisonnex and Cessy are shown in Figure II.5 for the period 1990 to 2003.

In 2003, the averaged NO_2 concentration at the station Maisonnex, as calculated from the collected data, is underestimated because the station Maisonnex was out of operation during the month of December – a month when higher NO_2 concentrations occur. The annual limit of 30 $\mu g/m^3$ was not exceeded since 1993. The annual averages were rather decreasing over the last ten years. However, as observed by the measurements carried out by the Swiss authorities (ROPAG) in the Geneva area, and by those of CERN in its station Cessy, the NO_2 concentrations seem to increase since 2002 [17]. For ozone, no clear long-term trends can be identified through the annual averages. As shown in Figure II.6, the number of instances when the acceptable average hourly ozone concentration of 120 $\mu g/m^3$ was exceeded was particularly high at the station Cessy in 2003, mainly due to the exceptional meteorological conditions. It is worth stressing that the station Cessy is located off wind of all CERN accelerator ventilation outlets.

2.3. Emissions from accelerator ventilation outlets

The monitoring programme of NO_x and ozone in exhaust air from proton accelerators was carried out from 14 May 2003 to 2 December 2003 at the ventilation outlet of the transfer tunnel TT10 (PS to the SPS accelerator). The maximum recorded half-hourly averages was below 48 $\mu g/m^3$ for NO, below 51 $\mu g/m^3$ for NO_2 and below 96 $\mu g/m^3$ for ozone. These figures show that emissions are well below the limits during the accelerator operation.

Based upon the maximum recorded NO and NO_2 concentrations and a maximum ventilation rate of 50’000 m^3/h, the total emissions of nitrogen oxides (NO + NO_2) were less than 5 g/h. As shown in Table II.5, this is well below the emission levels above which monitoring is required. For ozone there are no applicable emission limits as it is in general a secondary pollutant (see section 2.1).

Table II.5: Swiss [3] and French [7] emission limits for nitrogen oxides (NO + NO_2).

	Emission limits of nitrogen oxides (μg/m^3)	Note
Swiss	250’000	To be taken into consideration when the emission exceeds 2500 grams/hour
French	500’000	To be taken into consideration when the emission exceeds 25’000 grams/hour

3. Comparison between CERN and ROPAG results

In this section the results of CERN measurements are compared to those obtained by the Swiss authorities via the ROPAG network (*Réseau d'observation de la pollution Atmosphérique de Genève).* Results of the CERN station Maisonnex are compared with those produced by the ROPAG station in Meyrin. The station was selected for its proximity to the CERN Meyrin site and to the CERN monitoring station located in Maisonnex. The results of measurements performed at the station Cessy are compared with the ROPAG station Passeiry. This station is located in a rural area comparable to the location of the CERN monitoring station in Cessy. The locations of the ROPAG air monitoring stations relative to the CERN air monitoring stations are shown in Figure II.7.

3.1. Trends in 2003

The monthly averages of nitrogen dioxide and ozone concentrations at the CERN and ROPAG stations for the year 2003 are shown in Figure II.8 [17]. The ROPAG station in Meyrin measured significantly higher nitrogen dioxide concentrations than the CERN station Maisonnex due to its proximity to an urban area. During the summertime, the monthly averages of O_3 concentrations are highest at the ROPAG station Meyrin and CERN station Cessy and quite low at the CERN station Maisonnex. Statistics given in Table II.6 shows that the number of instances when the acceptable average hourly ozone concentration of 120 μg/m^3 was exceeded was more important at the ROPAG station Passeiry (rural area) than at the ROPAG station Meyrin (suburban area), and very low at the CERN station Maisonnex, although not so far located from the ROPAG station Meyrin. As already noticed in the previous years, local conditions may strongly influence the ozone concentrations.

Table II.6: Number of instances when the average hourly ozone concentration of 120 μg/m^3 was exceeded at the CERN and ROPAG stations [17].

	Locations/Number of instances			
Year	CERN-Maisonnex	CERN-Cessy	ROPAG-Meyrin	ROPAG-Passeiry
2003	1	446	433	605
2002	20	129	160	37
2001	90	12	260	188

3.2. Long term trends

The monthly averages of NO_2 and O_3 concentrations at the CERN and ROPAG air monitoring stations, for January, June and September are shown in Figure II.9 and in Figure II.10 for the period 1990–2003 [2, 17]. These months were chosen in order to reflect seasonal variations, including also the CERN accelerator shutdown in wintertime and the accelerator operation in summertime.

In 1996 CERN heating plant changed from heavy fuel oil to gas and since that time the NO_2 values measured at the CERN station Maisonnex are generally lower than those measured by ROPAG. This is also partly due to the location of the stations. The ROPAG station of Meyrin is closer to the city than the CERN station, and Passeiry, which shows in general higher concentration than Cessy, gets more pollutants from Geneva, especially during frequent north-east winds. The ozone concentrations shown in Figure II.10 are roughly the same at the four air monitoring stations in the last years, except the CERN station Maisonnex, which recorded lower concentrations in 2003.

3.3. Results of the comparison

The data collected by CERN are consistent with those obtained by measurements carried out by other institutions in comparable areas.

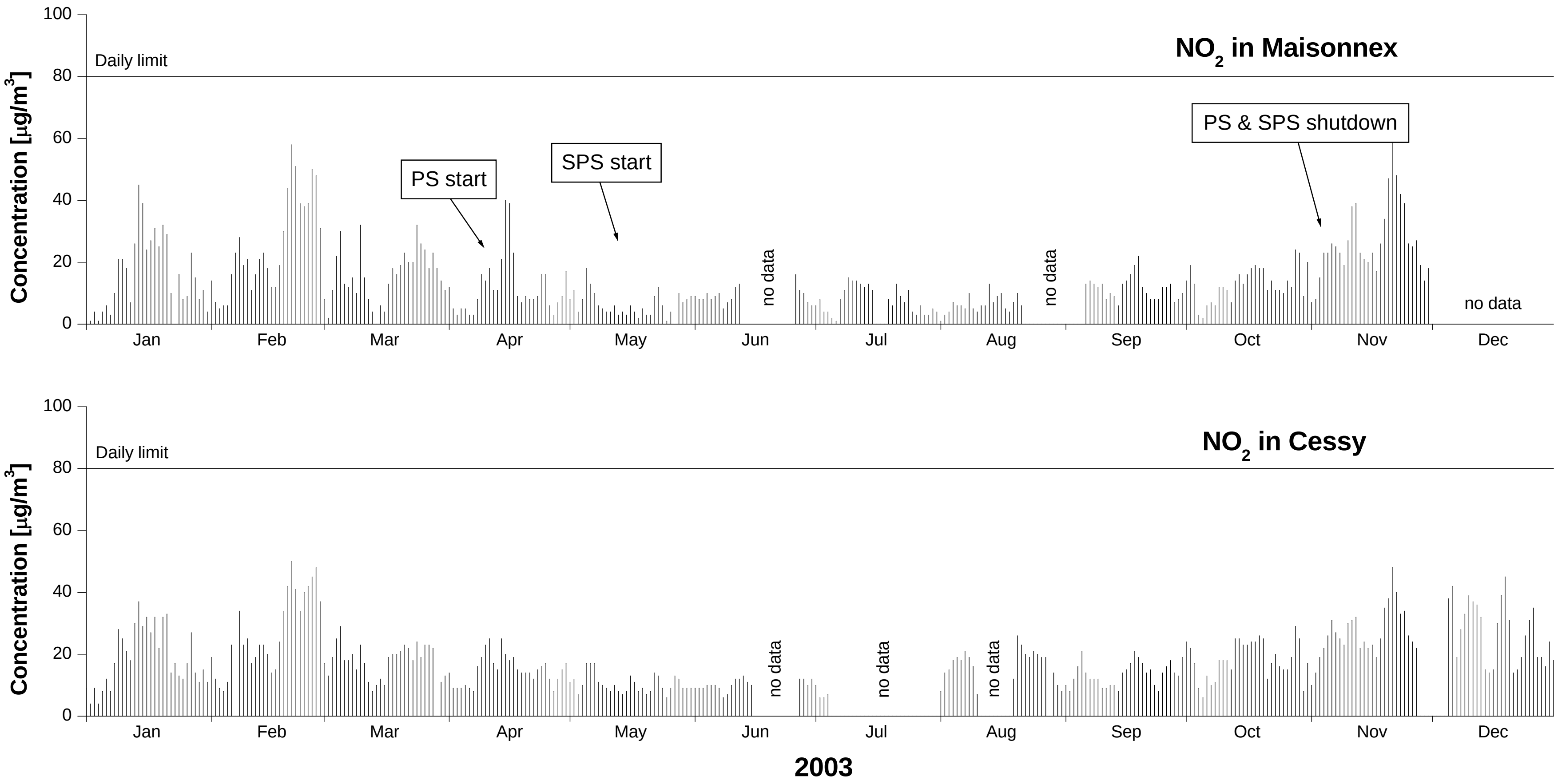


Figure II.2: Daily averages of NO_2 concentration in 2003.

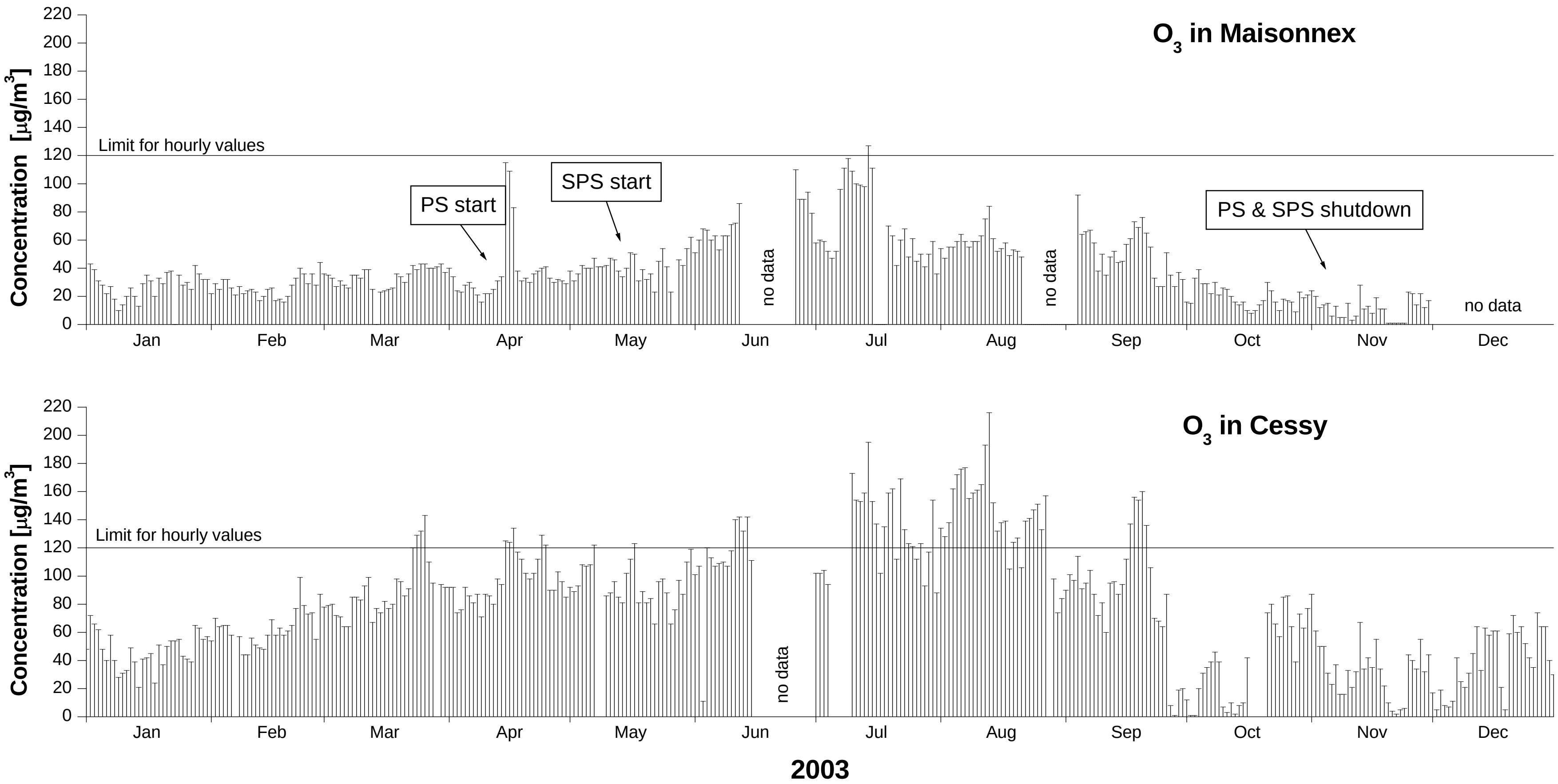


Figure II.3: Maximum hourly average of O_3 concentration during the days in 2003.

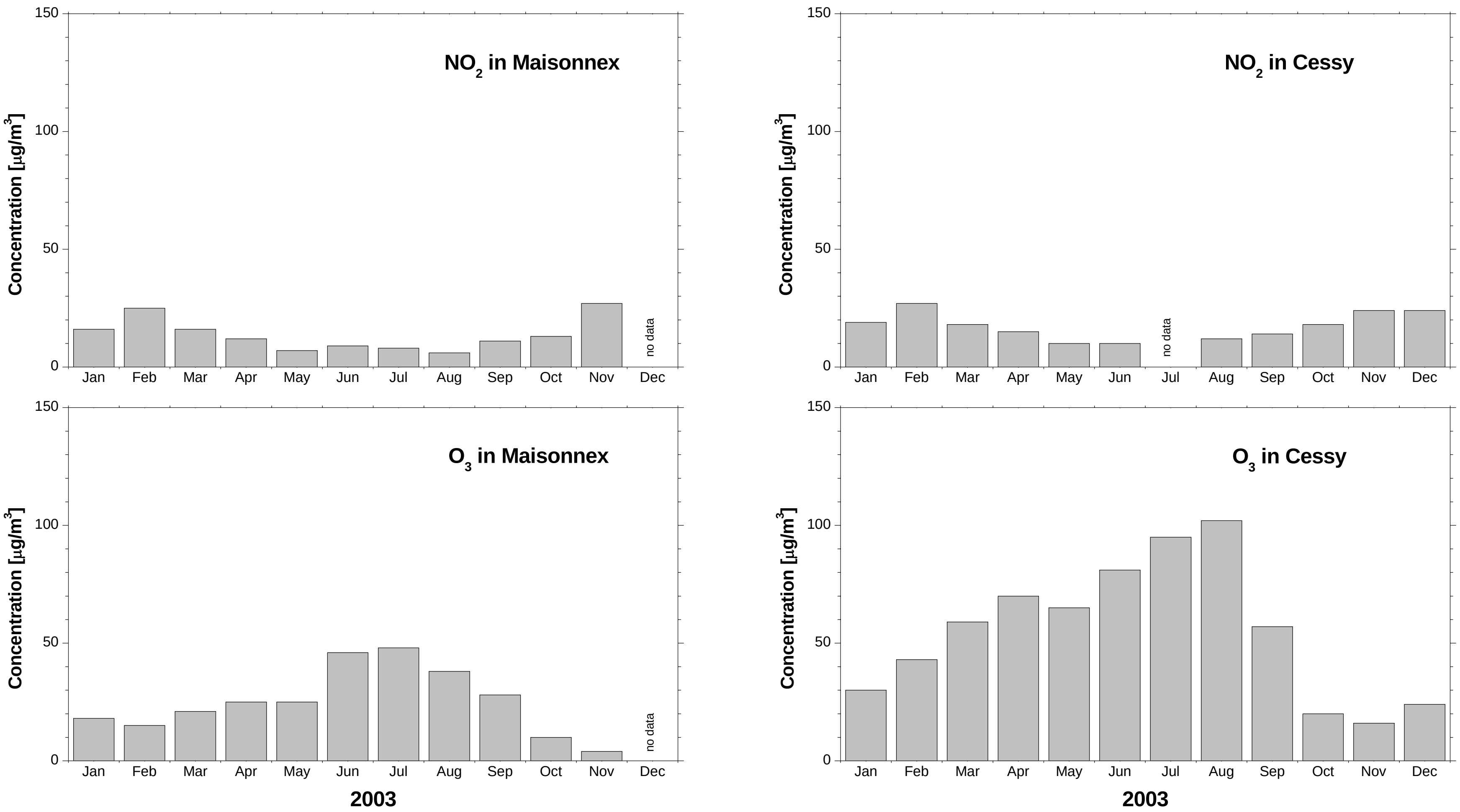


Figure II.4: Monthly averages of NO_2 and O_3 concentrations in 2003.

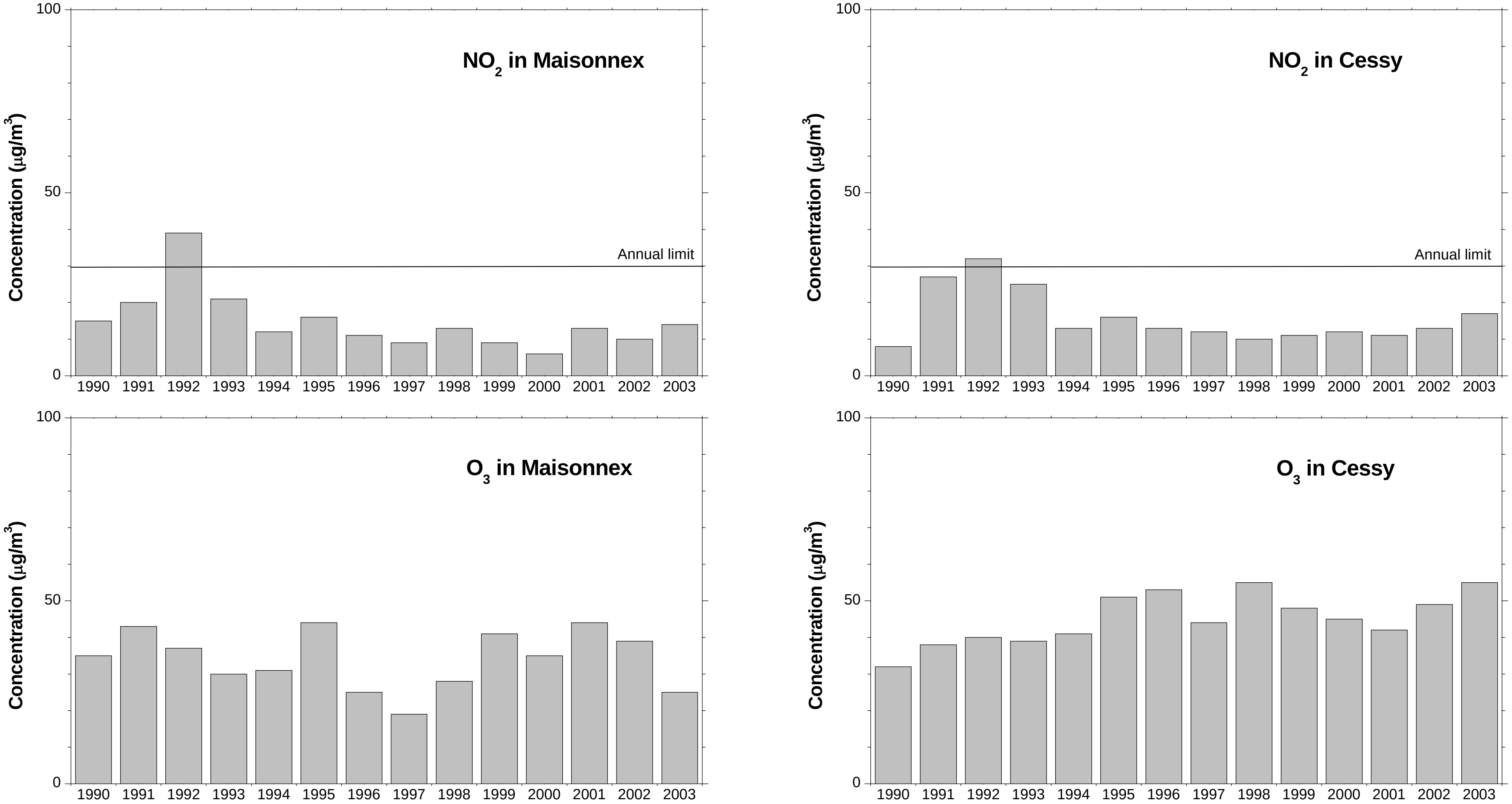


Figure II.5: Annual averages of NO_2 and O_3 concentrations since 1990.

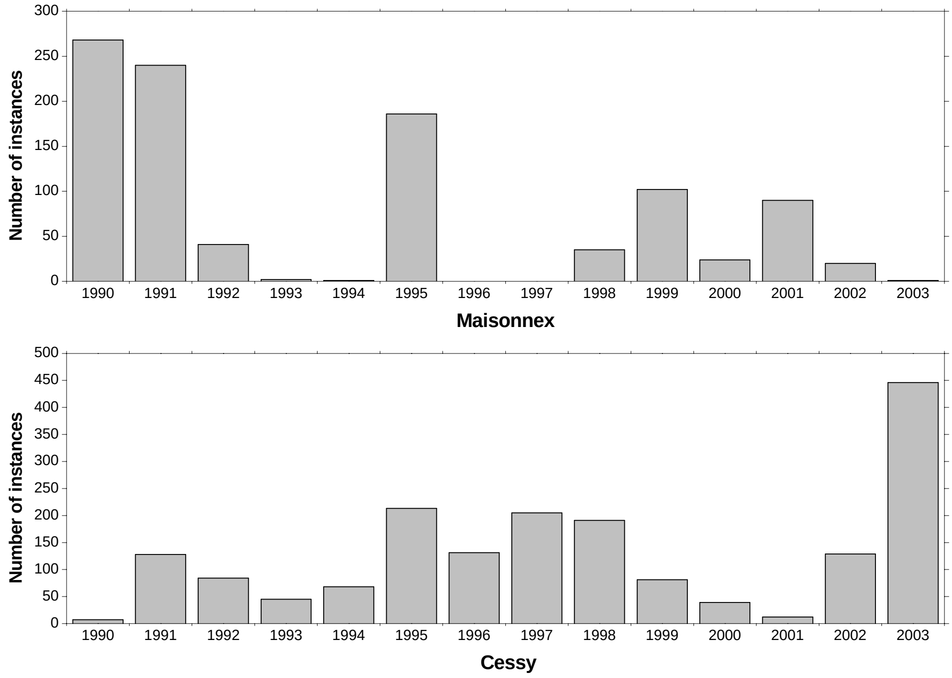
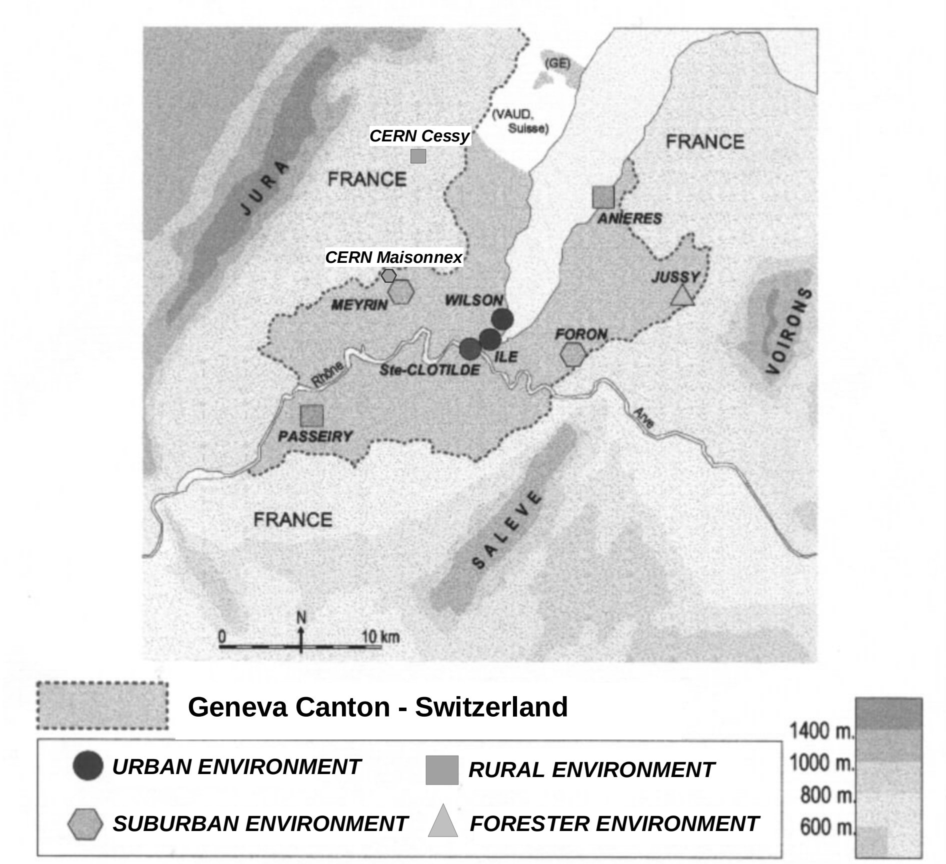


Figure II.6: Number of instances when the average hourly ozone concentration of 120 μg/m^3 was exceeded (the limit should not be surpassed more than once per year).



Adapted from: Service scientifique de l'environnement, République et Canton de Genève, Mesure de la qualité de l'air à Genève (2003)

Figure II.7: Location of the CERN and ROPAG air monitoring stations.

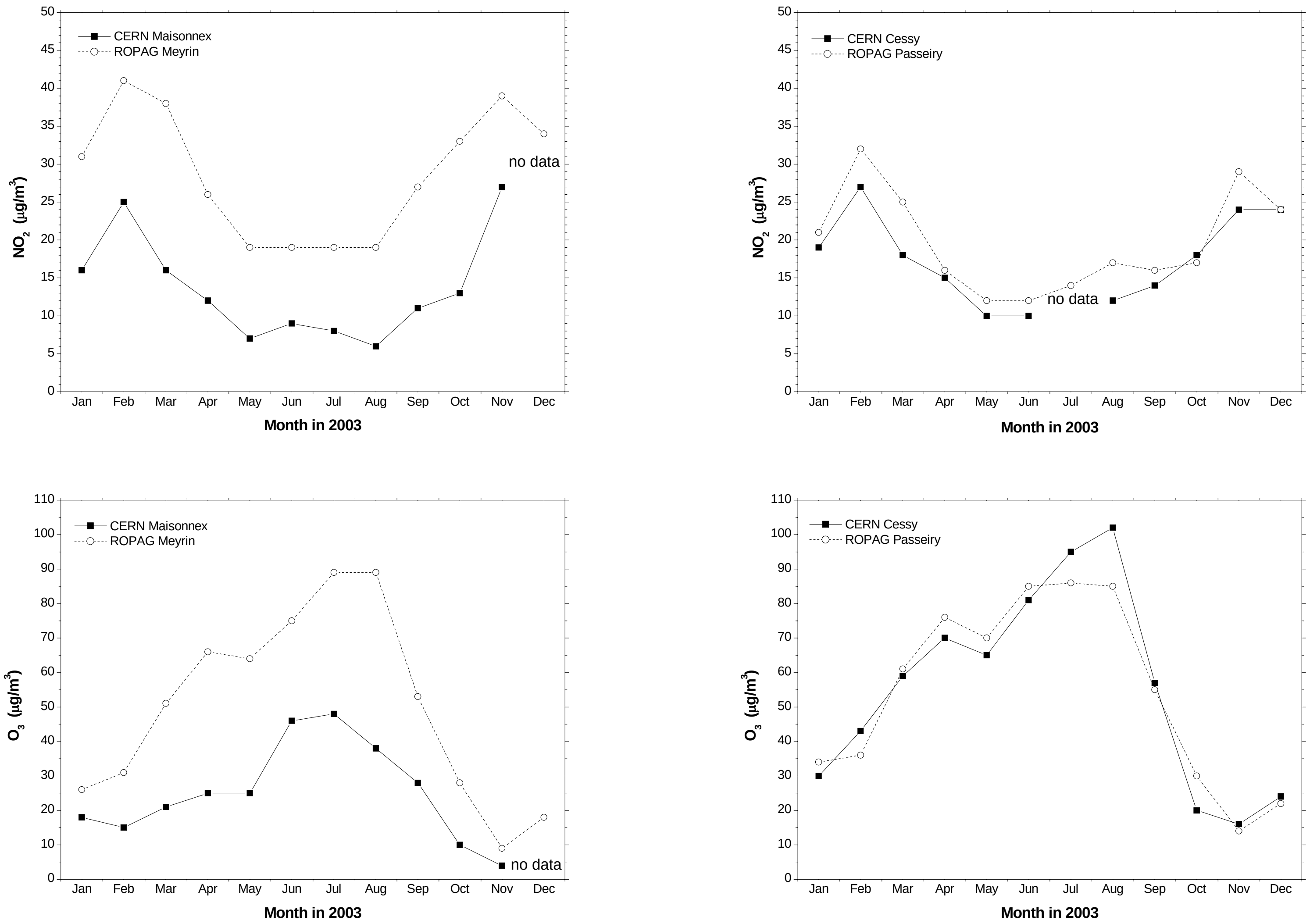


Figure II.8: Monthly averages of NO_2 and O_3 concentrations at the CERN and ROPAG stations for the year 2003.

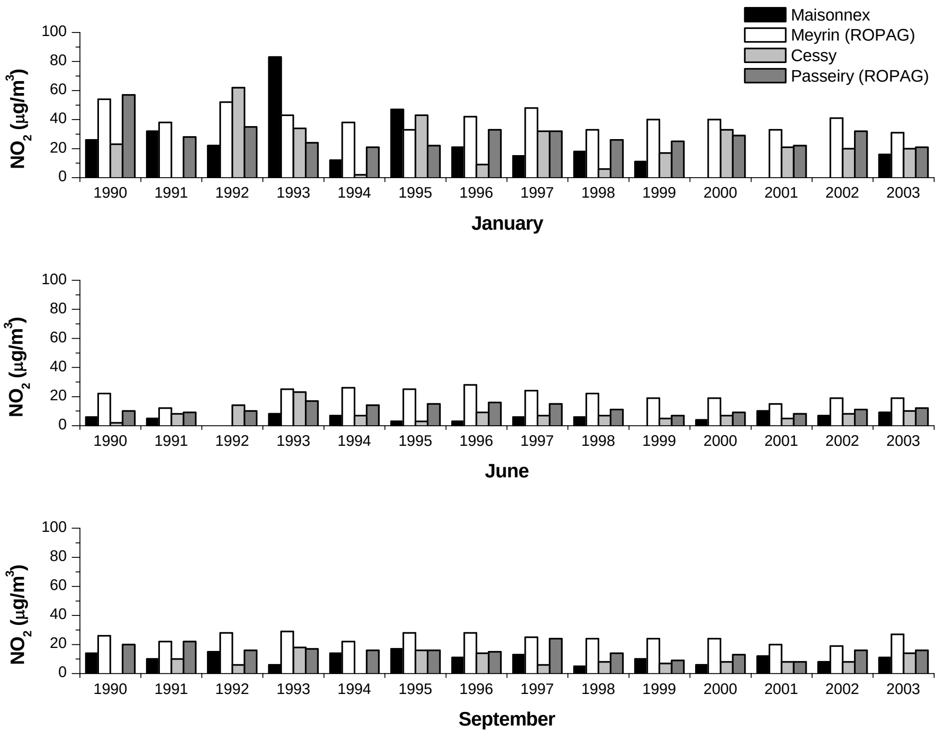


Figure II.9: Monthly averages of NO_2 concentrations at the CERN and ROPAG air monitoring stations.

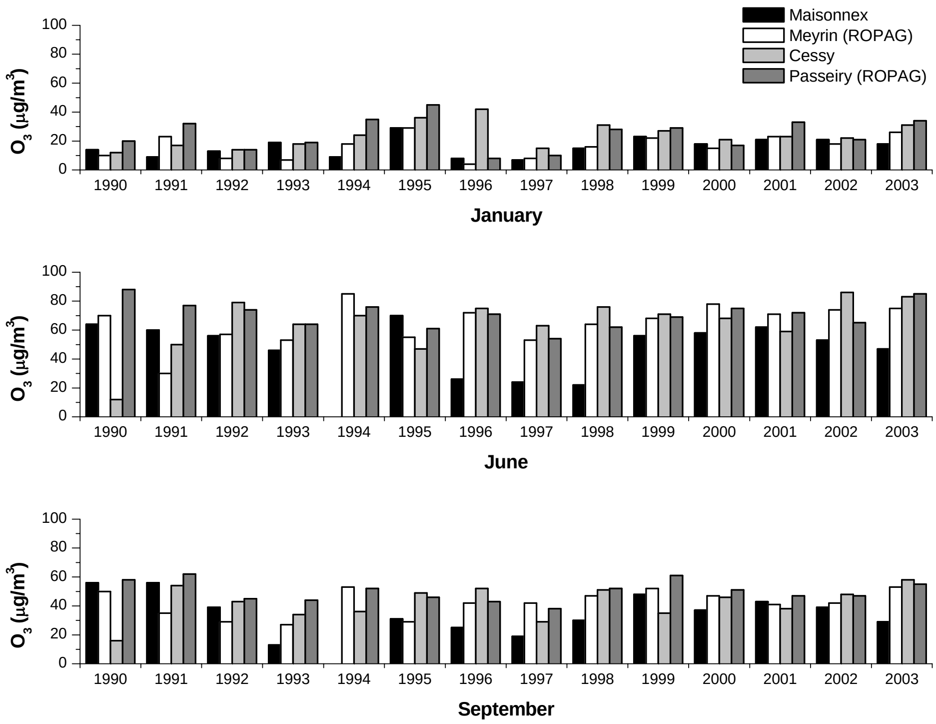


Figure II.10: Monthly averages of O_3 concentrations at the CERN and ROPAG air monitoring stations.

CONCLUSIONS

During the year 2003, the continuous pH and temperature measurements and the periodic detailed analyses performed in effluents released from the CERN Meyrin and Prévessin sites, showed compliance with the regulatory limits [6, 7]. A few cases of non-compliance were detected over the reference year that had a negligible impact on the quality of the receiving river water.

The environmental measurements carried out in the water of the rivers Nant d'Avril, Le Lion and streams receiving water from the LHC sites, showed that pH, temperature and concentration of dissolved oxygen remained within the limits [6, 7, 10]. Only in few punctual cases the concentration of dissolved oxygen was lower than the guideline value. These cases occurred during the summertime, when the concentration of dissolved oxygen is lower due to increased water temperature. This phenomenon was more important than in the previous years due to the exceptionally hot and dry weather in the summer of 2003. In general, the measured parameters in the water of the rivers and streams followed the natural seasonal variations and no significant negative effect of water releases from CERN was observed.

The periodical checks carried out by CERN of the rivers and streams receiving effluents from the LHC and CNGS civil engineering worksites revealed five cases of non-compliance, three of which were originated in the LHC PA6 worksite, one minor case in the LHC PA7 worksite (underground area) and one case in the CNGS worksite. Compared to the year 2002, less cases of non-compliance occurred in 2003 mainly due to decreasing number of worksites and to changed activities (concreting completed). In each case of non-compliance, the polluted effluents were quickly stopped and the contractor took corrective measures to prevent further incidents. The quality of the receiving watercourses was affected only locally in these few short-lasting cases. The most important event concerned an oil spill which significantly affected the pond located on the LHC PA6 site. However, the site was rapidly cleaned up and no impact on the biotope pond was observed.

The CERN air-monitoring programme is set-up to monitor the possible influence of the accelerator operation on the ambient air quality. In 2003, this was achieved by measuring the concentration of nitrogen oxides and ozone in the ambient air, downwind of the CERN Meyrin site (station Maisonnex) and at the ventilation outlet of a transfer tunnel between the PS and SPS accelerators. The data collected at the station Cessy (F) were used as background values. During 2003, the concentrations of nitrogen oxides and ozone were recorded by the Maisonnex monitors 82% and 83% of the time, respectively. For Cessy, the concentrations of nitrogen oxides were recorded 84% of the time and data on ozone concentration were collected for 92% of the time.

Neither the nitrogen dioxide nor the ozone immission levels were influenced by the operation of the CERN accelerators. Meteorological conditions, traffic, industrial and domestic heating and other emissions were the main causes of the measured variations. Values measured at the CERN stations were generally lower than those measured by the Swiss Authorities in comparable monitoring environments in the Geneva area. The annual trends were the same.

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